Developing Critically Thoughtful e-Learning Communities of Practice

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Abstract: In this paper, we consider an approach to developing critically thoughtful e-Learning communities of practice—where participants are deliberate about the use of specific intellectual tools supporting critical thinking. We address Garrison & Anderson’s (2003) argument that such critical thinking should play a central role within the ecology of e-Learning communities and provide our view of what such communities might look like. To do this, we offer four categories of strategies helping to develop such communities—collaborative agreement on goals; facilitator(s) modelling and teaching the tools supporting critical thinking; and shaping communicative interactions within the e-Learning environment to encourage thinking. We provide examples from a current study involving 36 kindergarten to grade 12 teachers’ blended use of information and communication technologies (ICT) and face-to-face sessions to illustrate our view.

Keywords: critical thinking, communities of practice, tools for thought, e-Learning.

1. Introduction

We believe the development of critically thoughtful communities of learners is an essential element for successful e-Learning. Despite its value, there is evidence, within conventional classrooms, that developing communities of thoughtfulness (COT) is more wish than practice (Goodlad 1994; Paul, Elder and Bartell 1997; Case 2006). We have not seen convincing evidence that e-Learning environments are any different in this respect. Fortunately, there are features of e-learning that are particularly suitable for promoting critical thinking (CT). For example, Garrison & Anderson (2003) claim that the “collaborative yet reflective process of e-Learning has great potential for facilitating critical thinking as a core goal of education” (p 58). However, we cannot simply assume that these potential opportunities will lead to tangible results. The literature suggests that rather than improving thoughtfulness, participation in e-Learning often leads to confusion and loss of interest unless there are strategies designed to enhance CT opportunities (MacKnight 2000). Drinkwater et. al. (2004) add that one of the challenges for ICT users is to understand how e-Learning technologies can “improve thinking”—and this is the focus of this paper.

More specifically we describe efforts to adapt The Critical Thinking Consortium’s (TC2) method of teaching CT for use within an e-Learning community of 36 teachers. The teachers are currently participating in a two-year project to use CT within a newly mandated social studies curriculum. We use preliminary findings collected during the first four months of the implementation project to illustrate our view of COTs. Our purposes are to offer (1) a view of what critically thoughtful e-Learning communities might look like and (2) provide anecdotal indicators of participants’ thoughtful interactions within the e-community we are currently studying.

We begin with a brief overview of the TC2 method, which provides our conceptual framing of CT. While the model offers four fronts for teaching CT, our primary focus is on the community of thoughtfulness aspect of the model. Then, we define and discuss our view of critically thoughtful e-Learning communities of practice, add the four categories of strategies used to support COT, and then use these strategies to illustrate what such a community looks like. Finally, we offer concluding comments.

2. Conceptual framework (the TC2 model)

The TC2 method of teaching CT is founded on the belief that people are attempting to think critically when they thoughtfully seek to assess what would be sensible or reasonable to believe or do in a given situation (Case & Daniels in press). This need to reach reasoned judgments may arise in countless kinds of problematic situations and can inform a routine approach to supporting interactions and making decisions within an e-community. Such situations require CT because “there is some doubt as to which is the most appropriate of several plausible responses and because these situations involve criterion thinking.” The power of the model is that it offers four coherent fronts providing a method for encouraging, teaching, and assessing the qualities of good thinkers. In the discussion of each front (sections 3-6) below we include examples taken from the dialogue between participants involved in the study described in section 7.
3. Providing critical challenges

The first front is infusing opportunities to think critically, what we refer to as challenging questions. This involves the development of a question form that:

- requires judgment;
- involves meaningful subject matter;
- addresses key aspects of the inquiry;
- and requires that participants either possess or can reasonably acquire the needed intellectual tools.

These critical challenges differ from two other commonly asked kinds of questions that focus on knowledge acquisition or mere opinion such as: Who invented the microscope? Or Which novel do you prefer? Examples of critical challenges using content from typical school curriculum are: Who has the greatest mind: da Vinci, Newton or Einstein? Or in Hamlet, who is the more noble character: Laertes or Hamlet? We argue that these kinds of question play a key role in engaging students in a topic and include use of criteria for judgment i.e. greatest mind and more noble character.

One such challenging question arising early on within the e-community considered here is - What would the most effective name for our group be? This question came about as participants in the study discussed the community’s shared goals and identity and at first appears to be superficial and unimportant. As illustrated later, this question ignited a substantial discussion within the e-community resulting in the development of a clear focus for our work together. We use this example below to elaborate on the other aspects of the model.

4. Teaching the tools

The second and most crucial front is helping participants nurture the use of five categories of intellectual tools (hereafter referred to as the tools) used by competent thinkers. These include: criteria for judgement, background knowledge, critical thinking vocabulary (concepts), and habits of mind. Below, we define each category and provide examples based on the challenging question asked by members of the study after their first face-to-face meeting. The “group name” in question was eventually resolved through on-line discussion before the second meeting a month later. The consensus name is “Project CSI”—Critical Thinking in social Studies Inquiry group—which identifies the focus and nature of their work together.

Criteria for judgment — the grounds for deciding between viable alternatives. Consideration of useful criteria resulted in an on-line discussion/debate characterized by the following posting about the question: What would the most effective [criteria for judgement] name for the professional group be?
Hi Everyone,

As you’re thinking of names, perhaps we could consider these as criteria to guide us:
1) memorable (catchy, fun, quirky or ....)
2) succinct (not too long like the one we started with in September)
3) representative (should be indicative of our collective identity and/or purpose) Participant #14

Background knowledge — the information about a topic required for thoughtful reflection. For a conventional course this includes the objectives typically outlined in the syllabus. In the above example, group members purposefully researched and eventually found out what made for an effective title, knowledge that later informed individual and small group decisions about titles for various curriculum development projects.

Critical thinking vocabulary — the range of concepts and distinctions that are helpful when thinking critically. It is important to distinguish between this vocabulary and content specific vocabulary. The CT vocabulary referred to here includes thinking-related concepts such as bias, inference, fact, opinion, etc.

For example, within the challenge considered here, understanding assumptions, or inferences associated with various suggestions was important. Indeed, during the “name-game” discussion referred to above, several participants questioned why certain names were considered and then offered counter arguments. In the end, the group came to a consensus and now use the agreed upon title often when referring to their work together.

Thinking strategies — the heuristics, organizing devices, models, and algorithms useful in making a decision. These include the strategies effective teachers use to help students organize and make sense of subject matter. These include listing positive and negative factors, graphing, collecting and assessing evidence, debating, ranking, etc.

For example, participants offered various pros and cons associated with different possible titles suggested in response to the “group name” question.

Habits of mind — the values and attitudes of a careful and conscientious thinker. These include such dispositions as open, fair and independent mindedness, as well as being circumspect, empathic, reflective, critical and humble among many others.

Within our group name example, participants appeared to be open-minded as they considered alternative ideas and were fair-minded as they assessed the advantages of different proposals.

Together, these five categories of intellectual tools provide for a comprehensive list of intellectual tools that support the development of sound thinking abilities. While this is a limited explanation, TC2 has identified many such tools including examples of how to teach them that will be published by TC2.ca as “the tool kit.”

5. Assessing the tools

The third front is regular assessment of competence in using the intellectual tools. For formal education situations (courses) this requires the careful development and use of appropriate criteria and clearly articulated standards to assess students’ use of the tools for thought. Within informal education environments, such as the one described below, the facilitators engage in on-going formative assessment to decide when to teach the tools for thoughtful participation in a COT and how to shape communicative interactions within the e-Learning environment that encourage and support thoughtfulness.

6. Conceptualizing communities of thoughtfulness (COTs)

The fourth and final front is building communities of thoughtfulness where the focus here is on developing thoughtful e-Learning communities. We begin our description of what this looks like by defining and elaborating on the notions of thoughtfulness, community, practice, and e-Learning community used throughout the paper. We then use examples from our current study to illustrating what such communities look like.
Case and Daniels (in press) provide the definition of thoughtfulness underpinning the conception. They argue that someone is being critically thoughtful when “thinking through problematic situations about what to believe or how to act where the thinker makes reasoned judgments that embody the qualities of a competent thinker”—(use the intellectual tools described earlier).

We also borrow from Lipman (1991) and Newman (1991) to provide an understanding of the community aspect and offer four constitutive features that define a community. Communities arise when participants:

- are committed to a common goal;
- interact in collaborative pursuit of their goal;
- agree on the general procedures;
- and assume individual responsibility.

This suggests that decision-making within an effective e-community is not an either/or proposition, rather it is a shared responsibility. As Barell (1995) and Resnick (1989) point out, participants’ sense of being able to influence their learning, as opposed to relying exclusively on someone else to direct them, is a significant factor in encouraging community members to “think for themselves.”

Building on the above principles, we also take account of Wenger, McDermott & Snyder’s (2002 p 9) understanding of practice. Participants in such a community of practice share frameworks, ideas, tools, information, style, language, stories and documents as knowledge and resources enabling the community to proceed with their inquiries. Within our study, both, the periodic face-to-face sessions and the variety of ICT mediated interactions, involve aspects of such practical knowledge participants bring to their work together.

Finally, we take account of Rogoff’s (1994) understanding of learning-oriented communities. Rogoff observes that collaborative participation and decision-making involving differentiated roles and responsibilities underpin learning communities. She concludes that for such environments to be effective, the following additional principles inform interactions:

- decision making—facilitator and participants negotiate mutually acceptable decisions;
- teaching/learning methods—facilitator orients, and mentors while participants engage rigorously with the subject matter in concert with others;
- practices—facilitator teaches the “tools” to enable participants to reach thoughtful responses to structured, but open-ended tasks;

Within such an environment, the facilitator’s roles are to frame the tasks, actively mentor participation, and provide support in developing the tools needed in order to reach thoughtful conclusions. For their part, participants work within various negotiated structures and shared norms as they engage seriously with the subject matter.

A critically thoughtful e-Learning community of practice requires taking account of the above defining aspects resulting in the need for use of the following categories of strategies within such communities:

- collaborative agreement on goals, routines and activities;
- facilitator(s) personally modelling critical thinking;
- facilitator developing/identifying and teaching the tools supporting a critically thoughtful community;
- participants shaping communicative interactions to encourage thinking.

7. Considering the strategies for supporting thoughtful e-Learning communities of practice

7.1 Background and the learning environment

In this section, we use the categories of strategies to organize and explore examples of dialogue from our current study to illustrate what such thoughtful communities looks like. The examples used are taken from the first six months of a current two-year study where 36 practicing pre-school to grade 12 teachers have volunteered to participate in professional development aimed at implementation of a new social studies curriculum within the Province of Alberta, Canada. The teachers are drawn from a large geographical area.
about half the size of Great Britain and working situations ranging from a one-room Hutterite Colony school to Public Secondary Schools in cities of about 80,000 inhabitants.

Professional development (pro-d), as used here, refers to participation in activities (typically workshops) focused on introducing teachers to new curriculum and teaching methods. The approach taken includes monthly fact-to-face session (large and small groups) with between-session use of various ICTs to support learning. In addition, the three facilitators supporting the e-Learning use the concept of communities of thoughtfulness outlined above to inform their work. It is also important to note that a central aspect of the pro-d program is teaching teachers about the TC2 method.

The ongoing use of ICT includes WebCT discussions and chat rooms, e-mail, video, live classroom and video/telephone conferencing. The face-to-face sessions are planned by facilitators as occasions for teachers to learn about aspects of the TC2 method. The small group sessions are intended as opportunities for participants to plan and develop collaborative inquiry projects like those outlined below. The variety of ICTs used is intended to help teach and extend understanding of CT and to support participants’ various inquiries.

Our overall study involves inquiry into these teachers’ developing understanding of CT methods and their use of various ICTs to support their small group inquiries. Dialogue about these small group inquiries forms the basis of the e-Learning community and is the source of examples offered. Below we briefly describe the group inquiries and then elaborate on the four categories of strategies using examples from participants e-discussions.

7.2 Participants’ inquiries

The participants quoted below are involved in developing, piloting and refining curriculum products as a critical inquiry oriented approach to implementing the new Alberta Social Studies curriculum. It is their shared inquiry that underpins the community of practice or as Lipman (1991) and Newman (1991) suggest, constitutes or defines the community. The kinds of curriculum products take varied forms including:

- developing lessons to adapt textbook resources for different learning abilities;
- assembling exemplars for use in guiding assessment of critical thinking;
- creating lessons using literature that integrates social studies and language arts with critical thinking;
- integrating ICTs such as smart boards, social learning software, web quests and with critical thinking.

For example, one group calling themselves 7 for Socials 7 are developing a set of resources for teaching and assessing grade seven students’ habits of mind. Another group has decided on a critical question involving comparison of different cultural groups from the region. One participant proposes:

*Hi Group;*  
*I’ve gathered some info and ideas on [First Nations] Potlatches and developed activities comparing the traditions of potlatches to [European] Christmas traditions.*  
*I don't know how to word the critical challenge or even if this is a good task.*  
*I need some feedback! Please! Thanks a bunch #10*

This group meets weekly using ICTs to share and critique aspects of their progress. The dialogue between groups such as the 7 for social 7s and among the whole group provides the examples used below to illustrate or view of a thoughtful e-Learning community of practice. As indicated earlier, we use the four categories of practices to organize and illustrate our view.

7.3 Collaborative decision making

The first category of supporting practice is collaborative agreement on, and implementation of, appropriate goals, routines and activities. From the beginning of the project, participants have collaborated to decide everything from the name of the group (CSI: Collaborative Social Studies Inquiry), to the dates and time of face-to-face and virtual sessions, to the focus and nature of their small group inquiries. This has required that participants:

- make up their own minds about most aspects of the project;
provide reasons supporting different positions;
consider several possible options or pros and cons for aspects of the project.

All this within an environment where:
respect and sincerity are expected;
use of the CT vocabulary is normal;
participants solicit ideas and suggestions from others;
participants are encouraged to explore or defend positions from various points of view;
praise is offered for thoughtful, insightful or empathic responses over merely correctly recalled ones.

The following excerpt from a group working to develop an inquiry into use of criteria to help focus on re-naming categories of tools in “kid Language” is typical of the strings both within small groups and between the entire group. The tone of appreciation, the use of CT tools and the critical give and take of ideas are typical within the community.

#17 ... this is awesome. Can I say that I am jealous of you being able to have such fun with this stuff. I did a similar thing with

Background Knowledge... I call it "What do you know?"
Criteria for Judgment ..... I call it “How will you decide?”
Critical Thinking Vocab .... “How will you say it?”

and so on, I don’t have the document right here in front of me but I have found it increasingly effective to pare down the vocab to an understandable level for young students. I will send you the whole list of my ideas when I return to school. Participant #11

While we will not complete a comprehensive analysis of data until later this year, it is commonplace throughout the data to find lengthy exchanges between both the whole group and the smaller inquiry groups where participants are engaging in exchanges about their goals and activities

7.4 Facilitator modelling

The second category of practices involves the facilitator(s) personally modeling the attributes—the intellectual tools—of a good critical thinker. We have found that it is important for facilitators to be explicit about their use of sound thinking and respectful discussion within their postings. Both facilitators working within the study try to do so whether they are discussing use of the technology, aspects of critical thinking, or providing feedback about other ideas being considered within the community.

We have learned from classroom experience (Case & Balcaen, 2007) that at the very least, facilitators need to:
- Not be dogmatic and not always have “the” answer
- Provide “good” reasons for decisions and actions;
- Be willing to change their mind when other good reasons are offered;
- Acknowledge the existence of different positions on issues.

In the posting that follows, the facilitator is trying to not be dogmatic while still raising a thoughtful question for the participant who has asked about the effectiveness of her ideas. He is also attempting to model the existence of different perspectives on the issues by placing himself in a student’s position.

Hello Participant # 9

I sure agree that there is a lot of great work going on and wish that I could be closer to and part of the fun. The characters you are developing to represent different habits of mind are great and the graphics engaging. When I looked at Jack Rabbit, for example, I wondered about using kid language for the criteria that would better compliment the rest of the graphic? I might just be soooo far out of context for this suggestion/question to be meaningful— I was just trying to put myself in a student's place.

Facilitator # 3
In another posting, the facilitator responds to a technology related problem when a participant asks for clarification. She offers a helpful source of background knowledge, takes a non-dogmatic position, and encourages a collaborative approach to problem solving.

Hi # 4, Thank you for letting me know that you had a problem. I will be creating a help document for posting discussions in the coming day or two and will post it in the tutorials area. If you could look at this and see where the thing falls apart - that may be helpful for sorting out what happened. Facilitator # 2

As is the case throughout much of the data reviewed so far, both facilitators are making efforts to model and be explicit about the attributes of good critical thinking.

7.5 Teaching the tools for participation

What we have learned from previous work is that without teaching and assessing for the tools for critically thoughtful participation, we cannot reasonably expect the emergence of a critically thoughtful e-community. Here the tools for thought are often learned within the context of experiential face-to-face sessions augmented by video/audio interactions and various forms of e-dialogue. The e-discussions play a significant role in teaching and extending the thinking tools used by participants. These include but are not limited to:

- use of criteria such as relevance and clarity;
- developing the essential background knowledge needed to participate;
- developing or extending understanding of key thinking vocabulary such as unanimous, consensus, minority position, or inference;
- developing thinking strategies such as critiquing in a non threatening manner (using questions, beginning with a positive);
- and supporting the development of the *habits of mind* used by a critical thinker such as being independent minded, sensitive to others and self-monitoring.

The following note, like many others, illustrates one member of the 7 for social 7 group’s modeling of several of these tools. She extends the thinking strategy of comparison to include students role-playing of pro and con positions and suggests going beyond this to a debate. She also uses questions effectively to provide feedback about areas lacking clarity and needing further elaboration. Her tone indicates that she is quite sensitive to the person she is responding to.

Hi # 10

I liked your idea of relating Potlatches to Xmas. The comparison would make Potlatch a lot more real to students. I thought the write up on Potlatches would be easy for grade five students to understand. I didn’t quite understand gifts as payments. Could you explain that for me?

I was also wondering about adding an extra activity to follow the comparison. What about having some groups of students being pro Xmas/potlatch and other groups being not so sure about the celebrations. Groups, based on the point of view that they are asked to take could rate the different aspects of Xmas/Potlatch and then write an argument for their stance. This could possibly be turned into a debate (I have the rules for debating). I am not sure what the big question would be or whether there needs to be one. # 32

While the facilitators periodically take on an instructional role within the e-discussions, most often it is other group members, such as 32, who extend understandings considered during previous face-to-face sessions to help advance others.

7.6 Facilitator designing a communicative environment to support thinking

The central role of a facilitator in such a community is that of designing and shaping the communicative interactions within the e-Learning environment to encourage thinking. Case and Balcaen (2007) identify whole group discussions, facilitator interactions with individual participants and communications among participants as three categories of interactions that support thinking.

*Whole group discussions*—occur within the face-to-face sessions and frame the whole group e-discussions within a *Main* folder established on the first day of work together as well as several others (the name game, assessment, and future chat room topics) established after subsequent face-to-face sessions. Small inquiry
groups have established their own folders where they carry on focused discussions about their work together. Following Case and Balcaen (2007), we argue that effective whole group discussions are encouraged by:

- limited input from the facilitator;
- the use of questions that invite debate and require the use of criteria to make judgments;
- contributions that are substantive and worthwhile;
- and when all participants are invited to participate equally.

In the study we find that facilitators often limit their input to teaching and advancing use of the tools, providing clarification in response to questions, or raising challenging questions for the community at large. The following posting from a discussion about assessment issues illustrates the kind of facilitator input within the general community dialogue. Here, in a typical note, the facilitator provides limited input, identifies other useful sources of information and invites all participants to respond to a substantive and worthwhile question.

*Attached is a document produced by teachers in BC that is focused on assessment issues and portfolios that might be of some use. You might also be interested in an online discussion on assessment with Prof. Rob Tierney from UBC planned for this week at the Community Updates cite. I wonder what the most important assessment challenges facing you and others are as we begin to consider assessing critical thinking as part of our projects? Facilitator 3*

**Communication with individuals** — While much of the facilitators’ input to the discussions is intended for the general audience, at times they must respond to individuals. The following three strategies generally help students answer questions for themselves and we find these techniques in several facilitator postings.

- Turn the question back by asking questions like; What is your best guess? or How would you respond if asked this question?
- Prompt with clues or hints or offer an example or new situation that might help them see their response as problematic.
- Suggest tentative answers, including those that many participants would see as flawed such as, I’m wondering if it might be? or I’m not certain, some people might think….

In the following posting, the facilitator uses these strategies when responding to a request about whether a particular board game would work as a critical challenge.

*I don’t know if any of what I have offered is even helpful. What do you think? I’m wondering if the students could be asked to design their own board game for grade 5’s? Would that work? Facilitator # 1*

**Communications among participants** — Peers provide most of the individual feedback within the study. This kind of feedback is essential within a critically thoughtful community because it involves thinking critically about another’s work. That is, participants are offering assessment based on identifiable criteria such as engaging, interesting, well organized, or justifiable. Within the study, participants were offered the following suggested strategies about feedback that supports thoughtfulness.

- Emphasize positives as well as things needing improvement
- Frame things needing improvement in the form of a query such as “I am unclear why you did it this way. Could you explain?”
- Initially, encourage suggestions for improvement that are low risk, easy to perform and have obvious benefits.

For example, the following anonymous posting was in response to a video-conference where small groups presented the inquiry ideas they were working on.

*I am very appreciative of the presenters who bravely opened their inner workings to the group. I wonder if for critique purposes it would have been helpful to have the written materials available beforehand. I was impressed by the thought behind and quality of both projects presented.*

These three forms of communications supporting thoughtful communities together with collaborative decision making, facilitator modeling, teaching the tools for participation provide a practical view of a thoughtful e-leaning community of practice in action. However, we must acknowledge that like most e-Learning
environments, not all interactions involve what we would characterize as thoughtfulness. We are impressed by the changes we see as the project proceeds and will report on these when the study concludes.

8. Discussion and conclusions

In our paper, we have argued for and outlined a view of critically thoughtful e-Learning communities of practice. Our initial review of data indicate that the professional development facilitators are practicing the four categories of strategies that we believe are useful in developing thoughtful e-Learning communities by: encouraging collaborative agreement on goals, routines and activities; modelling critical thinking; teaching the tools supporting a critically thoughtful community; and shaping communicative interactions within the e-Learning environment to encourage thinking. Dialogue within the large and smaller inquiry groups of participating teachers indicates that at least some of the participants are using the identified tools demonstrating the thoughtful form of participation that we hope for. The most telling demonstration of the emerging critical community is that many participants are volunteering to present their curriculum products at a symposium within a forum where they will be open to peer critique.

References


Competency - and Process-Driven e-Learning – a Model-Based Approach

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Abstract: As a matter of fact e-Learning still has not really caught on for corporate training purposes. Investigations on the reasons reveal that e-Learning modules like WBTs often miss any relevance for the tasks to be accomplished in the day-to-day workplace settings. The very learning needs both from an organizational and individual perspective are neglected. Content brought to the learner very often meets neither the individual competency gaps nor the organizational learning goals. Time passed between acquisition and application of knowledge is too long. In short, business processes on the one side and learning-related processes on the other are not aligned adequately. Thus, we see an urgent need for concepts on how to derive corporate training actions from business tasks in order to improve employees' business performance. This paper presents an integrated approach for competency- and business process-driven learning management supported by information technology (IT), developed within two projects named PROLIX and EXPLAIN.

Keywords: authoring, business process management, competency development, learning content, learning objectives, learning processes

1. The need for business relevant content

Investigating reasons why e-Learning does not really catch on for corporate training purposes reveals that e-Learning modules like WBTs exhibit only little significance for actual learning needs both from an organizational and individual perspective, and is often irrelevant for the tasks to be accomplished in daily workplace settings. Content brought to the learner very often meets neither the individual competency gaps nor the organizational learning goals. Time passed between acquisition and application of knowledge is too long. Altogether, business processes on the one side and learning-related processes on the other are not interlinked adequately. As a consequence, employees are little motivated to pursue online courses which do not help them, neither to improve their performance on current tasks nor to solve any recent problems. Thus, there is an urgent need for concepts on how to adjust corporate training actions to the context of business tasks in order to improve employees' business performance. Only if they are closely coupled to business operations and their respective need for learning, innovative technology-enhanced learning (TEL) will be adopted at the workplace. Without a sufficient integration of business requirements into e-Learning authoring, any corporate training solution is doomed to fail.

The idea pursued proposes business process models as a requirements basis for the production of learning modules providing problem- or task-oriented content. Enhanced by additional information like employees responsible, supportive software, business goals and most of all competencies required, they represent the context of business situations. Matched with individual competency profiles, they provide information about those very competency gaps that constitute the personal learning objectives. This competency- and process-based context information is used to answer didactical and structural questions for the learning module to be produced. Furthermore, it facilitates the search for suitable material based on metadata. Hence, a learning module can be developed that fulfills the learner’s immediate needs in his specific working role as an employee. Supported by easy-to-use and low-cost IT-systems, the approach enables instant learning activities by reducing the time-to-competency. The concept is demonstrated along the prototypes of two ongoing research projects, PROLIX and EXPLAIN, both dedicated to process-oriented integration of core business and learning-related functions in general and authoring activities in particular.

This paper presents an integrated approach that allows for business-relevant learning content by leveraging business process management to enhance training material with competencies required for improving employees’ business performance.

2. Business processes as context for competency-driven learning

Business Process Management (BPM) has become an established approach in business management theory and practice over the last twenty years, the two most important concepts being Business Process Reengineering (BPR) and Continuous Process Improvement (CPI) (Hammer & Champy 1993) (Scheer
Implementing new or enhanced processes, which are usually supported by IT, aims at improving efficiency and effectiveness of business operations.

On the search for connections between learning and business concepts, the process entity reveals itself as intersection between both areas of analysis. A business process is defined as “a continuous series of enterprise tasks, undertaken for the purpose of creating output” (Scheer 2005). Overcoming functional isolation of departments imposed by structural or hierarchical organizations, process orientation has brought to business management a more dynamic, customer-oriented perspective on the operative, tactic and strategic activities. Today, most organizations and their supporting ICT systems have incorporated processes as central business objects. They use process-driven ICT architectures such as ERP, SCM, CRM and Business Intelligence tools that support employees in the process execution. Companies manage their businesses along their processes, starting from design over execution to controlling and monitoring of the processes what in the end feeds back into improved business process design. As this process lifecycle has become the central instrument of business management, it lends to be the leverage for a process-driven learning management as well.

The execution of business processes and thus their performance are decisively influenced by the knowledge and competencies of the employees involved (Remus 2002). Vice versa, changes in business processes have an impact on the required competencies, employees have to hold for an adequate execution of the business tasks. The employees thus become a central resource for companies since they possess the relevant know how or the “intellectual assets” (North 1998). The continuous enhancement of employees’ competencies is therefore an important precondition for process optimisation.

The significance of employees as potential knowledge carriers indicates the high importance of a competency-related approach to the planning and management of business processes. This leads to the conclusion that in business process modelling, an integrated view of business processes, organizational structures, information systems etc. with knowledge and competency is needed. Questions that are to be gathered from competency-oriented business process models are:

- Which knowledge categories are present in a company (implicit/explicit)?
- What competency is needed for the execution of a certain function or process?
- Which organizational unit or which employee needs and uses the necessary knowledge?
- Which information systems contain stored knowledge?

Competency-oriented BPM has to take into consideration existing approaches and systems for BPM, learning and knowledge management (Bullinger & Schreiner 2001) (Gronau 2005). Currently, many different information systems exist in the market, which support a broad spectrum of functionalities in the respective fields of BPM, knowledge management and e-Learning. However, they lack the integration across the fields necessary to support the requirements described above.

2.1 A process-driven learning lifecycle

Being the semantic interface of business ICT infrastructure, business processes represent the potential linkage between learning and business systems. A business process provides the context information necessary to identify learning needs and design matching learning material that is meaningful for organizational business goals and individual learning goals (Specht 2006). This paper aims to position the thesis of a reciprocal relationship between business and learning processes leveraging future workplace learning and competency development. Hence, the process lifecycle serves as a conceptual framework to add business relevance to the most innovative learning infrastructures and thus making them economically sustainable.

As Figure 1 illustrates, a business process lifecycle encompasses the following three steps (Scheer & Schneider 2006): At first, in order to master complexity of an enterprise environment, business processes are modelled according to business requirements. As the term implies, a business process model reflects business operations by focusing on relevant activities, their timely or logical interdependences while leaving out secondary details. Thus, it serves as a basis for the second phase of implementing business processes into software systems. Therefore, the modelling phase is often assigned to build time of business application software. Having the business logic embedded, enterprise systems – most prominently ERP solutions such as SAP R/3 – automate business processes accordingly ensuring their execution as process instances (run time). Last but not least, such a software-based process automation allows for measuring business key
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performance indicators (KPI) within the systems which provide information that feeds back into business process (re)design (control time).

Figure 1: Integrated business and learning process lifecycles
Throughout the lifecycle, the process model represents business requirements, i.e. the factors that drive an organization’s success or failure. As a business process focuses on functions which are to be carried out in order to achieve a certain output, an enterprise’s success depends on the proficiency of the employees in charge of these activities. This is where learning enters the stage: Functions of a business process model determine learning goals. They define competencies for both individual employees and the entire organization necessary for smooth process execution. Moreover, organizational roles assigned to process functions are made up by a set of skills and competencies. Given this demand-driven linkage between business processes and organizational learning, the process lifecycle suggests to be applied to learning processes as well. Structuring learning process management in analogous phases of design, execution and control provides a common ground for interlinking business and learning processes. However, it must be understood that these interdependencies do not only occur within the phases but also across them. Thus, correlations as indicated in the figure are primarily of illustrative, rather simplifying purpose.

Given the close linkage between learning and business process as well as the advanced automation of both concepts, combining business systems and learning systems promises to leverage a series of synergies:

- **Learning needs identified at the point of action** within a business process can be directly translated from the given context to adequate learning processes that help to close the competency gap and therefore improve the individual performance in the process.
- Information and explicit knowledge generated and used within business processes such as product development can be **directly transferred to the content development** (authoring systems) instead of laboriously collected ex-post.
- Personalized, adapted learning activities are integrated into ongoing business tasks and challenges (**ambient workplace learning**).
- The impact of accomplished learning processes on the business process performance can be closely measured, compared to business goals and provide feedback for future training design, ranking of available learning objects for that business context, etc.

To achieve these objectives, innovative and extended methodologies, architectures, frameworks and tools that support the process-oriented deduction, retrieval as well as the distribution of relevant knowledge to the workplace learner are needed. The fulfilment of this vision will be tackled by the activities of the EU/IST IP on
“Process-oriented Learning and Information eXchange (PROLIX)” (URL:http://www.prolixproject.org). PROLIX’s major goal is to align people and processes in complex and dynamic working situations by addressing the needs of employees and companies at the same time. Due to this, it is aimed at creating and implementing an open, service-oriented technology enhanced learning architecture for process-driven learning and information exchange that supports a complete organizational and individual learning process lifecycle. (Martin & Wolpers 2005)

This paper focuses on modeling business processes and enhancing them with competencies as well as process- and competency-driven development of content within the build-time of a lifecycle. The following sections are to delineate potential synergies of combining both concepts and its implications further.

2.2 Existing methods for representing competencies in business processes

Best practices of BPM include modeling business processes in semi-formal diagrams that are easy to understand by business analysts and at the same time sufficiently formal to provide a technical basis for software implementation. The Architecture of Integrated Information Systems (ARIS) has become a widespread approach for business process modelling and management. The ARIS approach takes knowledge and competencies into consideration based on the assumption that all knowledge present in a company is related to business processes. Knowledge management encompasses the development, monitoring, support and improvement of strategies, processes, organizational structures and technologies. This includes all activities relating to the acquisition, preparation, transmission, and utilization of knowledge. Most of these aspects can be depicted using ARIS methods such as EPCs, organizational charts, function allocation diagrams, eERMs, etc.

Among a multitude of notations, the event-driven process chain (EPC) has become a de-facto standard for business process modelling. For an example see the ticketing process of a call center modelled as an EPC in Figure 2. Its strengths persist in the ease of use, i.e. simple syntax and clear symbolic representation that account for a wide field of applications ranging from process documentation, process optimization, cost control, up to implementation and configuration of standard software (Keller, Nüttgens, & Scheer 92 A.D.). An EPC consists of two basic constructs, namely functions and events. Functions are triggered by events and both are connected alternately to form a business process. Conjunctive, exclusive and disjunctive operators allow for a non-linear flow of control. Such rather simple EPC diagrams may be extended by other constructs, i.e. input/output data or organizational units. Modeling tools such as the ARIS Business Architect by IDS Scheer AG provide even a bigger variety of EPC entities to be assigned to process functions. Thus, the business process model goes beyond specifying which activities must be done and when. It gives additional details on further circumstances, which make up an employee's reality. Being enriched in such a way, the business process becomes the context of learning, i.e. acquiring those skills needed to perform the process effectively. As process models have proved to be efficient and sustainable storages and references of organizational knowledge, there have been some approaches to integrate knowledge and business process management [8].
However, if accurate representation, analysis, and improvement are required, additional means of representation are needed in order to identify and structure the content of relevant knowledge categories, to describe the distribution of knowledge within an organization, and to model knowledge creation and utilization in business processes. The current ARIS method provides two model types which make it possible to specify which kind of knowledge (general or documented) is necessary to perform a function and which knowledge is created and/or documented when the function is actually performed. This type of representation allows business processes to be studied in terms of the knowledge processing involved. For example, gaps in necessary knowledge can be discovered. Besides, the qualification profile needed to perform a function can be determined. ARIS proposes models for knowledge structures and knowledge maps which can be connected to business process models through the entity “knowledge” which is required for individual functions of a process (see Figure 3) (Allweyer & Jost 1999). However, such concepts have remained limited to knowledge structuring and modelling as the following sections will illustrate.

Knowledge Structure Diagram: Using a knowledge structure diagram, knowledge categories can be structured into subgroups. A knowledge category can include other knowledge categories or documented knowledge. Documented knowledge can again be divided into documented knowledge subcategories. The...
knowledge structure diagram can show the information media on which knowledge is documented and the application systems which serve to manage the knowledge.

A knowledge category aims at classifying the knowledge a company possesses or needs. Examples of knowledge categories are project management knowledge, specific industry knowledge, specific technology knowledge, customer and competitor knowledge, etc. Knowledge categories can contain implicit knowledge, i.e., knowledge that cannot be fully documented, employee or group knowledge in the form of skills, and explicit knowledge, i.e., knowledge that can be documented in the form of descriptions or technical drawings. Figure 3 shows an example of a knowledge structure diagram.

**Figure 3:** Example of a knowledge structure diagram

### 2.2.1 Knowledge Map:

A knowledge map shows the distribution of the various knowledge categories within an organization. To do so, knowledge categories can be connected with various organizational objects such as organizational unit, position, person, group etc. In addition, the degree of knowledge coverage can be specified for each organizational unit. A value of 100% stands for maximum knowledge coverage in a particular knowledge category. Next to this quantitative measure, a qualitative evaluation (low, medium, high, maximum) can be displayed in the form of a graph. There is no direct connection between the values for the degree of coverage and coverage quality attributes. If both attributes are used, it is suggested that the qualification “low” shall be used for a degree of coverage of up to 25%, medium for 25-50%, high for 50-75%, and maximum for 75-100%. Figure 4 shows a knowledge map that is organizational unit-oriented, i.e., for each organizational unit all relevant knowledge categories are indicated. It is also possible to select the knowledge categories as the central object and model the relevant organizational units around them.
Even though the knowledge diagrams belong to the existing ARIS method, they cannot provide a sufficient representation basis of competencies and competency profiles. An important issue that has to be taken into consideration is the nondisclosure of personal, i.e. of employee-related data. When knowledge or competencies are allocated to specific employees, process experts have to be aware that the collection, documentation, and particularly the electronic processing of such employee-related data are subject to many restrictions due to laws and company agreements. These have to be complied with when creating, using, or distributing information of this kind. Also the existing diagram types do not recognize the linkage to knowledge or skill requirements within a business process. Though, the contextual information given by a business process into learning goals provides the basis for translation of business-oriented requirements into corporate learning and training.

2.3 Competency-enhanced business process models

Using business processes for the distillation of learning requirements, i.e. competency gaps pose the question of how business process models can be extended by learning-relevant information, i.e. information that helps identifying companies’ training requirements as well as learners’ needs.

When reengineering business processes or offering new services, companies have to evaluate their organizational structure to staff the new processes. First, the competencies needed to execute the functions of the process have to be defined. At the same time, the competencies of existing employees have to be evaluated. These competencies are usually documented in the personnel file. Provided that competency-related information is documented in the process models, competency gaps can additionally be measured by analyzing the process flow in the operational systems. In addition, the different learning activities required to acquire new competencies should be described. By analyzing competency gaps and learning opportunities available, the organization can arrange training and staffing to get the best support for their processes.

Ideally, a company has already documented their business processes as a series of events and functions. From the perspective of competence modelling, this must be enhanced by information on the following aspects:

- **Organizational roles and responsibilities:** To specify which employee is responsible for what function / has to perform what task within a business processes, organizational role symbols are to be assigned to the functions.

- **Competencies needed:** To specify competency requirements, functions must be analyzed for the prerequisites an employee must exhibit to perform a task successfully. This leads to the definition of roles though a set of competencies needed to execute the role’s responsibilities.
**Competencies available:** To identify the learning need, the existing competencies of the individual employees must be gathered and documented in the model before they can be matched against the competency requirements.

Figure 5 and 6 show how competency-related information can be documented in a business process in a multi-level approach. Whereas Figure 2 exhibits the raw business process, figure 5 extends it by organizational roles and competencies needed. Enhancing the process model by competencies needed and employees involved is the first step towards an improved ticketing performance. Competence artefacts assigned to functions display what an employee being in charge of this activity must know or which skill he must be proficient in to perform the process according to the business goals. These competencies are the business requirements for corporate training in the short-term and personnel development in the long. Organizational charts assigned to the organizational units reveal who is in charge and again what are his/her current competence profiles.

**Figure 5:** Notation for competency-oriented modelling

Figure 6 illustrates how the matching of documented as-is and to-be competencies delivers the individual competency gaps resp. learning goals of each employees. The competence gap matrix reveals that generally employees of the First Level need to develop their conflict management and communication skills as well as enhance their product knowledge. This issue is mitigated by setting up a knowledge management base on all resolved tickets.
2.4 Process- and competency-driven content development

The competency-enhanced business process models, which are created in the design phase of the lifecycle, are used to answer didactical and structural questions as well as to enable the search for suitable content within the learning process. Having identified the competency gaps these can be taken over by the authoring team as learning goals to be addressed by individual e-Learning courses. Thus, a learning module can be adjusted to the learner’s immediate needs what facilitates instant authoring activities by reducing the time-to-competency.

Furthermore, the processes of learning material development are business processes themselves with multiple departments involved. Many interdisciplinary competencies and detailed knowledge (technique, tools, project management, media production, and didactic expertise) are needed to produce learning objects, WBTs or other training material. Existing tools support only singular aspects of the learning process production, but do not provide holistic process integration within the overall ICT landscape of an organization.

These issues have been elaborated within the research project EXPLAIN (http://www.explain-project.de) funded by the German Federal Ministry of Economy and Technology. EXPLAIN focuses on content development processes and aims at an intelligent ICT environment that empowers organizations to flexibly implement their learning objects in the course of their major business processes. The main objective of the innovative cooperative project is to develop a new generation of authoring management platform (Zimmermann et al. 2005). This will facilitate a simplified proprietary learning material development process and will enable organizations to produce their own multimedia trainings. The project’s development approach is based on a systematic analysis and reengineering of as-is content development processes in cooperation with professional authoring companies and industrial enterprises. From here, an integrated platform supporting the processes of content process management and content authoring including open interfaces to learning management systems and authoring tools is being prototypically implemented step-by-step (see Figure 7). Beyond process integration, a variety of additional services will further facilitate designing, producing and managing media and content (Chikova, Leyking, & Loos 2006).

The platform follows the thesis that it does not make sense for corporate training managers to run and maintain an own learning infrastructure within the enterprise and have all the skills in an internal team – unless the volume of media production is on a very high level. Therefore, the approach of EXPLAIN is to enable enterprises to produce their own learning material independently as well as to respond to ad-hoc learning needs in a cost-effective and time-saving manner. In doing so, a closed self-supply of e-Learning actions would be unrealistic and economically not reasonable. The intelligent integrated solution will instead provide a multitude of authoring tools, assistants and services on-demand over a web-based platform. The idea is that enterprises can use these services whenever they need it. So, services and tools can also be provided at the newest level of technology (Chikova, Leyking, & Loos 2006).

This demand-oriented approach provides a number of advantages for the user: On the one hand, corporate training departments avoid pre-investments into own infrastructures. Instead, appropriate tools can be utilized on-demand over the web-based platform and can be integrated into the overall project. In a similar way, this applies also for media production, which can be outsourced to external service providers or carried out in-house over the platform. Thus, even small education departments will be released from the necessity to provide all expertise, technology and resources by themselves, but nevertheless, they will still keep their
leading position within the learning projects. The central element in the overall process is represented by the content model, which, similar to a bill of materials used in product design and development, integrates all required activities along the structure of a learning module. Thus, it provides an interface between the processes of content management and authoring. Furthermore, the platform offers value-added services to the project team, like support in didactic issues, in selecting appropriate tools, in retrieving external media experts (photographers, audio studios, translation agencies, etc.) within a resource pool, as well as the provision of ready-made template and media asset libraries. These services will also support communication and collaboration activities within the team and by this increase the process efficiency for review and creative team processes (Zimmermann, Bergenthal, Chikova, Hinz, Lehmann, Leyking, Martin, & Rensing 2005), (EXPLAIN Consortium 2006).

Figure 7: EXPLAIN Authoring Management Platform

2.5 Process performance monitoring

Combined business and learning process control allows measuring the impact of learning and training on the execution of business processes within the organization. It is important to get a feedback about the learning process in order to improve adaptive, individualized learning material and learning design. Controlling learning processes from a business perspective is of great importance in order to know about the impact of the training on the business process execution and the process performance, as it is the main purpose of training to lead to improved processes. This means, employees who are already trained should perform better in their daily work. If not, the training is not sufficiently adjusted to the learning goals which correlate with business goals. Then the training content has to be (re-)engineered in order to optimize its effects on business process execution. In order to reveal the impact of workplace learning on the overall process, training measures must be added to the already common KPI of process monitoring system. This is where the true ROI ("Return on Investment"), i.e. the added value, is quantified and provides feedback for process improvement.

A business integrated learning design, learning material production and distribution to the learner create a comprehensive learning experience embedded in learner-oriented business process flows. This supports the understanding of transaction-oriented cause-effect relations, which aligns individual and organizational learning goals. Flexible knowledge distribution on the basis of an improved technology support provides only relevant information and learning material to the employees. Thus, it reduces time lags caused by competency deficiencies while enabling faster readiness for business tasks, faster decision making as well as a shorter response time to stakeholders. This generates a better performance in the business execution by the employee and an added value for the customer that contributes to a higher customer satisfaction.

Learning process control is regarded as a permanent activity and integrated into business process management, which is initiated on time, ideally before a competency gap will appear. It is able to steer planning, information and controlling processes of a learning management life cycle. As a result, not only direct learning success is measured, but also indirect effects to the business processes. The identified
cause-effect relations between learning input and work output will enable the definition of process and role patterns for evaluation-based learning process management and thus enable and realize feedback to the business process responsible on the performance of each employee.

3. Towards business-integrated learning management

This paper demonstrated along an extensive case study that business process models can serve as highly relevant requirements basis for indicating competency deficiencies that inhibit smooth process performance. Extended by required and existing competencies, process models document the gap between organizational competency requirements and individual competency profiles. The employees’ qualification as well as the enhancement of their competencies constitutes an important precondition for an effective and efficient business process execution, the accomplishment of change management and in terms of “Time-to-Competency” their ability to anticipate cause-and-effect relations of process and market changes better and faster.

The key innovation in PROLIX and EXPLAIN consists of a process- and competency-driven framework for interlinking business process (intelligence) tools on the one hand with knowledge management and learning environments on the other. Overall and seen from a managerial point of view, PROLIX and EXPLAIN significantly contribute to change management within companies that need to evolve to a holistic learning organization enabling the integration of learning processes into daily working tasks. In order to master pace of the globalizing world, a corporate culture of change must provide strategies, methods and concepts to satisfy diverse individual and organizational learning needs. Thus, learning is seen as a key enabler of business process change. Mechanisms and concepts for a company-wide introduction of TEL have to be coordinated with company philosophy and vision. Aligning learning with business processes based on advanced technology and competency matching is an important step towards a business-integrated learning management within the learning organization. Accomplishing this complex endeavour will open new segments of TEL and provide sustainable and transferable results, which contributes to the emergence of the information society as a whole.

References


The Impact of Learner Characteristics on Learning Performance in Hybrid Courses among Japanese Students

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Abstract: To improve the management of hybrid courses, the relationship between learner characteristics and learning performance was analyzed in two regular university courses. Undergraduate and graduate students participated in two
15-week hybrid courses which consisted of face-to-face lectures (Information Industrial issues), and the corresponding modules with online test. Subjects included 36 freshmen and 48 graduate students. Learner characteristics, consisting of motivation, personality, thinking styles and learners’ impression of their e-Learning experiences were measured at the beginning and end of the term. Additional data was collected from the number of days attended, the number of modules completed, test scores and final grades for the course. Final assessment grades for the class were also analyzed. There was no significant difference in learner characteristics between bachelors and masters students who completed the course. There was no significant difference in learner characteristics between bachelor and master students, but there were some differences in conscientiousness scores between masters and bachelor students and between those who received a final grade of A and B. Scores on ‘learning strategy’ as a factor to indicate learning experience were in favour of master students. Master students’ evaluation of their e-Learning experience increased significantly throughout the course. Conscientiousness (one of the five factors in the personality construct) correlated positively with the number of e-Learning modules completed by master students (r=0.35). They seem to understand better the benefits of e-Learning experience and being the more motivated students, they applied what they have learned from previous e-Learning experiences more effectively. Students with high grades evaluated their e-Learning experience positively and had significantly higher conscientiousness scores than master students who received lower grades (p<0.05). For bachelor students, the number of modules completed correlates with both intrinsic and extrinsic motivation. Other learner characteristics did not affect learning performance. The reason may be that bachelor students have yet to understand well the benefits of e-Learning and still lack the learning strategies needed for university coursework. The causal analysis was conducted using Structural Equation Modelling (SEM) technique, and the result indicated that learner characteristics had an effect on learning experience and learning performance. These results suggest that understanding the benefits of e-Learning and learner characteristics, as well as knowing how to learn with e-Learning content could provide important key for promoting student success in online learning.

Keywords: learner characteristics, blended learning, learning practice, learning performance, path analysis

1. Introduction

The growing use of online technologies for teaching and learning is renewing the demand for (a) better understanding of student characteristics that affect learning and (b) the effective design of online instruction. Even in the traditional face-to-face class, teaching and learning management is not easy, because the interaction is often complicated by numerous factors which include characteristics of learners and the learning content. And when online learning activities are customized to meet individual characteristics and learning needs, the importance and need for the role of a tutor or mentor often emerges. Various personalized teaching/learning strategies can also be integrated in online course design to benefit learners (Koen 2005). Moreover, the use of online teaching components together with face-to-face teaching could help meet individual needs as well as increase the opportunities to assist students in their learning.

Despite the benefits that have been reported in the literature on online teaching, there are also other issues that have been identified in relation to online teaching, particularly about online learners. Recent literature on e-Learning indicates that not all students perform successfully in online courses. This may be caused by factors related to the learning environment and/or personal characteristics. Research reports have indicated that student success is influenced by factors such as learning styles (Diaz & Cartnal, 1999; Gagne, Briggs & Wager1992; Terrell & Dringus, 2000; Zhang & Sternberg, 2001), self-directive competencies (Birch, 2002), and motivation (Pintrich & Schunk, 2002). Identifying learner characteristics for successful online experience was reported to serve the best interest of students (Wojciechowski & Palmer 2005) and should be part of any systematic design of instruction (Dick & Carey, 1996). Based on these findings, we have been conducting surveys of learners’ attitude since 2005, and have reported initial findings on learner characteristics as factors affecting student performance in hybrid courses (Nakayama et al., 2006).

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We expanded this 2005 survey on the relationship of learners' characteristics, learning experience and learning performance among university students by doing another survey and analysis of data collected from additional bachelors and masters students enrolled in a Japanese national university.

This paper will address the following objectives:

- To examine the impact of student characteristics on learning performance by measuring using various indices of learners who participated in regular hybrid courses in a Japanese university.
- To analyze the relationship among these indices, so that major influencing factors related to learner characteristics can be extracted
- To identify and examine plausible causal paths to learning performance from these characteristics

The goal was to extract effective management and instructional design methodologies for hybrid courses by investigating the above-mentioned relationships during an academic term when learners were engaged in the use of online materials. The rationale behind this goal is the need to support the "learning-to-learn" that takes place when students take hybrid courses, and to gain a better understanding of how learner characteristics may influence learning. As they move from a face-to-face to hybrid learning environment, students are often required to acquire new learning strategies and skills that go beyond the skills needed for the mastery of course content. Their learning and behavior undergo various forms of "shaping-up" as they go through the course. Therefore, focusing on the development process of e-learners in hybrid courses and understanding better their learning behavior or characteristics, can help obtain key points for effectively organizing hybrid courses in particular, or e-Learning in general.

2. Method

2.1 Survey group

Two credit courses which were offered during the Spring Term of 2006 were selected for this survey project. The first course was "Information Society and Careers", a 2-unit bachelor-level class for university freshmen, and the second course was "Advanced Information Industries", a 2-unit master's class for students on their first year of graduate work. For college freshmen, this is one of the first courses they take upon entering the university. Most of the students will be majoring in Engineering.

Both classes were taught by the same professor as 15-week hybrid courses at a Japanese national university. The hybrid courses consisted of regular face-to-face sessions, supplemented with e-Learning components in the form of corresponding online modules and tests. Students attended the face-to-face class and were able to access the online content from outside of class. Examples of a learning window and a testing window for the online content are presented in Figure 1 and Figure 2. Figure 1 shows a list of learning sessions which consist of modules that correspond to the course content covered in each face-to-face session. The modules include video clips of the instructor and the lecture for that session, plus the presentation slides which were used in the face-to-face lecture. Figure 2 shows a testing window which consists of test items for the learning content that was lectured in the face-to-face session. Most tests were conducted in the multiple-choice format. The learner can assess their responses and view their individual scores after completing the test. The learners are given as many opportunities as needed to retry and answer each question until they are satisfied with their own scores. This in turn motivates them to learn the course content well, using the accompanying video clips and presentation slides.

To encourage maximum participation in e-Learning, a benefit was explicitly provided to students: online test scores for modules will count towards their final grades in the course. Also, a student can make up for class absence by taking and passing the online test that corresponds to the face-to-face class session that was missed. This encouraged the students to do the online modules and test because missing a regular face-to-face class session often affects the students' final test scores and the evaluation of their learning experience. Most students are concerned about their performance and final grades. Thus, in these hybrid courses, online modules were counted as learning activities for the course and online test scores were also part of the grading system used for evaluating student final performance in the course. But more importantly, the online learning materials were designed to encourage students to catch-up with what they missed in class and to maximize their learning. This means that online modules for this course could become key learning activities for students.
Both classes were surveyed using the same constructs and questionnaires used in the earlier survey that was conducted in Spring 2005 (Nakayama et al., 2006). Also, the online materials used in the 2005 survey did not undergo any revisions when used in 2006, therefore learning content and materials were controlled. What may have changed are the instructor's teaching methodologies and learner's ability to learn in hybrid learning environments due to maturation effect. Also, there could have been an increase in the instructor's confidence in the effectiveness of online courses to promote student learning.

2.2 Survey instruments and data

To extract Japanese students' characteristics, four constructs were surveyed. These constructs were: motivation, personality, thinking styles, and self-assessment of online learning experience (Nakayama et al., 2006). The first construct is motivation, which was measured using a test inventory that was developed by Kaufman and Agars (2005), and which provided scores for "Intrinsic Motivation" and "Extrinsic Motivation" (Kaufman 2004). McCloy et al. (1994) defined motivation as "the combined effect of three choice behaviors: (a) the choice to expend effort, (b) the choice of what level of effort to expend, and (c) the choice to persist in the expenditure of the chosen level of effort." For the second construct, personality, the International Personality Item Pool (IPIP) inventory was used. Goldberg (1999) lists five personality factors and so for this construct, there were five components scores: "Extraversion", "Agreeableness", "Conscientiousness", "Neuroticism" and "Openness to Experience". There are multiple interpretations for these factors, for example, "Extraversion" suggests being sociable, "Agreeableness": being cooperative, "Conscientiousness": diligent or having a sense of responsibility, "Neuroticism": being very sensitive, and "Openness to Experience": relating to culture and intellect (Murakami & Murakami, 2001). Detailed inventory is available at the IPIP web site (International Personality Item Pool, 2001). For the third construct (thinking
styles), Sternberg’s functions of Thinking Styles provides three scores: "Legislative Style", "Executive Style" and "Judicial Style" (Sternberg, 1997; Matsumura & Hiruma, 2000).

The original English versions of the three survey tools used in this study have been standardized, and their validity had been established. However, no Japanese version was available, except for Sternberg’s Thinking Styles survey. Further, the validity of any version of the surveys translated into Japanese, had to be established. To generate the component scores from Japanese students, one of the authors (in collaboration with other colleagues) worked on the translation of all survey items into Japanese. A pilot test of the beta version of the translated versions was conducted with 28 graduate students prior to this study. Then, the translated surveys were revised based on student scores and feedback. To examine whether normal scores could be extracted from the Japanese survey data, the authors consulted with other psychologists about the possibility of this type of evaluation. The consultants agreed that the beta version can measure indices which can then be used as the extracted factors. The results were the Japanese versions of the three surveys which were developed and used in this study to collect data on learner characteristics.

The fourth instrument that was used to measure students’ online learning experience consisted of a 10-item Likert-type questionnaire. Each item required the student to rate each item using a 5-point scale: from strongly agree (5) to strongly disagree (1). All subjects were asked to rate their overall impression of the online course and their own learning habits and learning strategies. This questionnaire was administered twice: during the second week of the term and at the end of the course. This survey instrument has been used previously by the authors to measure learner’s attitude, and has been analyzed for its validity.

The students’ final grade for the course was based on various learning activities, which included the final test scores, their learning attitude (i.e., the number of class days attended), and their online course learning experience with modules and tests. Three indices were identified and used as indicators of learning performance: the number of days attended (NDA), the number of completed modules (NCM), and the online test scores (OTS). In particular, the number of days attended (NDA) is considered by most Japanese university students as a key factor that affects their final grade. Therefore, most students are mindful of their total class attendance. In the surveyed courses, both the number of completed modules (NCM) and the online test scores (OTS) were taken into account for NDA as mentioned earlier, and the participants had to pay attention to all indices: NDA, NCM and OTS.

Also each student’s final grade for the course (GRD), based on a 4-letter grading system, consisting of ‘A’ as highest grade to ‘D’ which is a failing grade, was used in this analysis. Since all students passed the course and received a grade of either A or B, they were divided into two groups, namely A-students (students who received a final grade of A) and B-students (students with a final grade of B).

3. Results

3.1 Learner characteristics

Component scores for the three constructs were calculated from item responses according to the established factor structure. Table 1 presents a summary of basic statistical scores across the two learning groups, Bachelors and Masters, which are further classified as A-students and B-students.

The rating scale or range varies among the three constructs: 1-10 for motivation, 1-5 for personality, and 1-6 for thinking styles.

In comparing the mean scores between bachelor and master students, no significant differences were found. This result illustrates the presence of common characteristics within a cohort group. The means did not depend on their development during the university life. The differences between the two groups based on their final grades were also tested for further analysis. Results indicate that there is a difference in conscientiousness, a personality factor, for both bachelor and master students (p<0.10), suggesting that conscientiousness may have had an effect on the final grade of students. In other word, the diligent students made effort for learning to earn A-grades in both Bachelors and Masters levels.
Table 1: Personal characteristics for bachelor and master students.

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<tr>
<th></th>
<th>Bachelor</th>
<th>Masters</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Grade=A</td>
<td>Grade=B</td>
</tr>
<tr>
<td></td>
<td>(N=24)</td>
<td>(N=12)</td>
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<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
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<tr>
<td>Motivation (1-10)</td>
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<td>Intrinsic motivation</td>
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<td>7.65(1.01)</td>
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<td>Extrinsic motivation</td>
<td>5.56(1.27)</td>
<td>5.80(0.87)</td>
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<tr>
<td>IPIP scale (1-5)</td>
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<tr>
<td>Extraversion</td>
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<td>2.88(0.79)</td>
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<td>3.40(0.38)</td>
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<td>2.95(0.51)</td>
</tr>
<tr>
<td>Neuroticism</td>
<td>2.95(0.60)</td>
<td>2.64(0.59)</td>
</tr>
<tr>
<td>Openness to Experience</td>
<td>3.07(0.63)</td>
<td>3.00(0.38)</td>
</tr>
<tr>
<td>Thinking Styles (1-6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Legislative Style</td>
<td>4.21(0.92)</td>
<td>4.16(0.97)</td>
</tr>
<tr>
<td>Executive Style</td>
<td>4.18(0.60)</td>
<td>4.42(0.98)</td>
</tr>
<tr>
<td>Judicial Style</td>
<td>3.61(0.78)</td>
<td>3.57(0.70)</td>
</tr>
</tbody>
</table>

3.2 Online learning experience

Students’ self-assessment of their online learning experience was conducted twice during the term, using a 10-item questionnaire. These ten questions were used to measure three factors: e-Learning overall evaluation, learning habits, and learning strategies (Nakayama et al., 2006).

There were 6 questions for Factor 1 (F1: overall evaluation of e-Learning experience), namely: Q1. e-Learning is easy to follow and understand, Q2. I learn better in online courses, Q3. Online materials are useful to me, Q4. It is easy to schedule online learning time, Q5. Online course content is interesting, Q6. Overall, online course is a favorable learning experience. For Factor 2 (F2: learning habits), the two questions were: Q7. I’m a conscientious student, and, Q8. It is my habit to do learning preparation and review; and for Factor 3 (F3: learning strategies), there were also two questions: Q9. I have my own method and way of learning, Q10. I have my own strategies on how to pass a course.

The scores that resulted from this survey were summarized according to these three factors. To compare the factor scores at the end of the term between the two learning groups (Bachelors and Masters), mean factor scores were summarized (see Figure 3). In this figure, the horizontal axis contains solid bars to represent the mean factor scores for L1, L2, and L3 for both bachelor and masters groups, and line bars are given at the end of the solid bar to represent standard errors. The mean scores for “e-Learning Evaluation” and “Learning Strategies” are distributed mainly around the mid-score of 3, which indicated a neutral rating or evaluation, while mean scores for “Learning Habits” were lower than the midpoint or neutral evaluation. This suggests that learners consider themselves to be insufficient in terms of having the necessary “Learning Habits”. In comparing mean scores between Bachelor and Master students, results indicate a significant difference in F3: learning strategies (t(70)=3.05, p<0.01). These results provide findings that freshmen do not seem to have sufficient learning strategies for university studies.

The university where this survey was conducted has been promoting online learning. Recently, some accredited online courses have been offered to masters and bachelor students, thus increasing the number of students who have taken online courses and an increase in the experience level of students as e-learners. Therefore master students, who have taken e-Learning courses in their undergraduate studies, may have gained and brought with them a useful understanding of the benefits of online learning and applied that understanding to this hybrid course. Masters students may have understood well the benefits of hybrid courses, however, the data analysis shows no significant difference.
To confirm the stability of F1 scores, data collected at the beginning of the term (April) were compared with data collected prior to the end of the semester (July). The results are summarized in Figure 4. The horizontal axis shows the month when the survey was conducted, and the vertical axis shows factor scores from 2 to 4. According to this figure, the factor scores for bachelor students were at the same level throughout the course, but scores of master students significantly increased as the course progressed, indicating that master students may have positively recognized the benefits of online courses, and have developed the strategies (e.g., access to online modules during that time of the day when they are most ready to study and learn) for e-Learning.

![Figure 3: Comparing factor scores of learning experience](image)

![Figure 4: Comparing factor 1 (e-learning overall evaluation) scores.](image)

Table 2: Correlation coefficients among three factors.

<table>
<thead>
<tr>
<th></th>
<th>July-April</th>
<th>Bachelors</th>
<th>Masters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L1</td>
<td>L2</td>
<td>L3</td>
</tr>
<tr>
<td>L1</td>
<td>0.46</td>
<td>0.44</td>
<td>-</td>
</tr>
<tr>
<td>L2</td>
<td>0.43</td>
<td>0.66</td>
<td>0.45</td>
</tr>
<tr>
<td>L3</td>
<td>0.53</td>
<td>0.60</td>
<td>-</td>
</tr>
</tbody>
</table>

L1: e-Learning overall evaluation; L2: Learning habits; L3: Learning strategies
Table 3: Learner statistics for classes.

<table>
<thead>
<tr>
<th></th>
<th>Bachelor</th>
<th></th>
<th>Master</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grade=A (N=24)</td>
<td>Grade=B (N=13)</td>
<td>Grade=A (N=34)</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NDA</td>
<td>13.92(0.88)</td>
<td>13.23(2.17)</td>
<td>14.23(1.00)</td>
</tr>
<tr>
<td>NCM</td>
<td>9.71(1.90)</td>
<td>8.00(3.11)</td>
<td>9.60(2.43)</td>
</tr>
<tr>
<td>OTS</td>
<td>89.56(9.09)</td>
<td>73.05(24.81)</td>
<td>96.15(4.35)</td>
</tr>
</tbody>
</table>

NDA: N of days attended; NCM: N of completed modules; OTS: online test scores

Results from further data analysis indicate that the F1 scores of A-learners increased significantly, but not the scores of B-learners. This suggests that the learner who recognizes the benefits of online learning gains to earn the highest possible final grade.

To examine whether the recognition of the benefits of online learning is based on one’s learning strategies, correlation coefficients among the three factor scores were calculated and are summarized in Table 2. The table shows lower triangular matrix for the beginning and upper triangular matrix for the end of class for bachelor students and master students respectively. As indicated in Table 2, for master students, there are no significant correlation coefficients between F1: e-Learning evaluation and F3: learning strategy. On the other hand, some bachelor students may consider online learning as another method or strategy for learning. These results suggest that students acquire some skills that go beyond the learning of course content as they proceed and manage their own learning in hybrid courses, and that there are some differences in the performance of masters and bachelor students. This difference in student performance could be attributed to student’s previous experience with hybrid courses and to differences in learner characteristics. This point will be discussed further in a later section.

3.3 Learning performance

Results of the three indices for learning performance - namely, the number of days attended (NDA), the number of completed modules (NCM) and online test scores (OTS) -- are summarized in Table 3. The two classes that participated in this study are completely different, so that it is not easy to compare the data directly. However, most of the indices show similar tendencies.

In comparing the two groups of students based on their final grades, the means for A-students are all higher than the means for B-students, with most standard deviations (SD’s) for B-students higher than A-students.

There is no significant difference on NDA because most students have attended almost all face-to-face class sessions. The difference in NCM between A-students and B-students in the masters group is significant (p<0.01) but there is no significant difference for bachelor students. Most Masters’ A-students preferred to complete the online modules in addition to attending face-to-face class sessions, and they also sought to get high scores in the online test. Therefore, they had more opportunity to take online courses, but B-students only have occasional experience in learning with online courses. This learning pattern may have had an effect on the students’ final grade.

In terms of online test scores (OTS), there are significant differences because this index has a direct effect on final grades.
3.4 Relationship between learner characteristics and learning indices

Table 4: Correlation coefficient (r) between learner characteristics and learning indices.

<table>
<thead>
<tr>
<th></th>
<th>L1</th>
<th>L2</th>
<th>L3</th>
<th>NDA</th>
<th>NCM</th>
<th>OTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLJ</td>
<td>0.40</td>
<td>0.43</td>
<td>0.33</td>
<td>-0.12</td>
<td>0.15</td>
<td>0.18</td>
</tr>
<tr>
<td>B</td>
<td>0.43</td>
<td>0.34</td>
<td>0.43</td>
<td>0.00</td>
<td>0.21</td>
<td>0.13</td>
</tr>
<tr>
<td>M</td>
<td>0.34</td>
<td>0.53</td>
<td>0.21</td>
<td>-0.25</td>
<td>0.16</td>
<td>0.07</td>
</tr>
<tr>
<td>EAE</td>
<td>-0.06</td>
<td>-0.02</td>
<td>0.07</td>
<td>-0.17</td>
<td>0.05</td>
<td>-0.13</td>
</tr>
<tr>
<td>B</td>
<td>-0.16</td>
<td>-0.33</td>
<td>-0.17</td>
<td>-0.20</td>
<td>0.08</td>
<td>-0.08</td>
</tr>
<tr>
<td>M</td>
<td>0.04</td>
<td>0.22</td>
<td>0.27</td>
<td>-0.14</td>
<td>0.01</td>
<td>-0.06</td>
</tr>
<tr>
<td>MOTIV</td>
<td>0.20</td>
<td>0.38</td>
<td>0.07</td>
<td>0.02</td>
<td>0.16</td>
<td>0.12</td>
</tr>
<tr>
<td>B</td>
<td>0.06</td>
<td>0.34</td>
<td>0.18</td>
<td>0.20</td>
<td>0.43</td>
<td>0.18</td>
</tr>
<tr>
<td>M</td>
<td>0.37</td>
<td>0.42</td>
<td>0.04</td>
<td>-0.14</td>
<td>0.01</td>
<td>0.06</td>
</tr>
<tr>
<td>CONSC</td>
<td>0.33</td>
<td>0.39</td>
<td>0.28</td>
<td>0.07</td>
<td>0.26</td>
<td>0.19</td>
</tr>
<tr>
<td>B</td>
<td>0.30</td>
<td>0.36</td>
<td>0.34</td>
<td>0.30</td>
<td>0.15</td>
<td>0.19</td>
</tr>
<tr>
<td>M</td>
<td>0.37</td>
<td>0.43</td>
<td>0.29</td>
<td>-0.10</td>
<td>0.35</td>
<td>0.09</td>
</tr>
</tbody>
</table>

L1: e-Learning overall evaluation; L2: Learning habit; L3: Learning strategies
NDA: N of days attended; NCM: N of completed modules; OTS: online test scores
OLJ: Openness to Experience, Legislative Style and Judicial Style
EAE: Extraversion, Agreeableness and Executive Style

To examine the correlation between learner characteristics and learning indices, correlation analysis was conducted. A number of correlation relationships emerged: the number of completed modules (NCM) for bachelor students correlated with both intrinsic motivation (r=0.33, p<0.05) and extrinsic motivation (r=0.44, p<0.01); NCM for master students correlated with conscientiousness (r=0.35, p<0.05). All correlations were related to NCM for online learning. This suggests that some learner characteristics affect their learning performance.

To examine the causal relationship among learner characteristics, learning experience and learning performance, further analysis was conducted. There were many variables for this analysis. To reduce the number of variables (i.e., characteristics), three joint-factors (Nakayama et al., 2006) were introduced. Factor analysis was conducted for all variables, and as an outcome, five factors were extracted and the first three factors were joint-factors. The first factor “OLJ” consisted of “Openness to Experience”, “Legislative Style” and “Judicial Style”. The second factor “EAE” consisted of “Extraversion”, “Agreeableness” and “Executive Style”, which includes a factor of “positive emotionality” as “Extraversion” and “Agreeableness” (Five-Factor model, 2001). The two motivation scores were summarized as “MOTIV”. The remaining two factors were the original “Conscientiousness” and “Neuroticism”.

As previously mentioned, “CONSC” (Conscientiousness) is the key factor for learning. Because “Neuroticism” does not explicitly affect learning activity, relationships were analyzed between learning experience, learning performances and the remaining four factors as learner characteristics. The correlation coefficients are summarized in Table 4. The correlation coefficients for bachelor students and master students are also summarized in the same format. The significant coefficients are indicated with bold lines. According to this table, there are significant relationships for joint factors “OLJ” and “MOTIV”, and “CONSC” with L1:“e-Learning overall evaluation”, L2:“Learning habit”, L3:“Learning strategies”, and the number of completed modules (OTS). Also, there is significant difference on some correlation patterns between bachelors and master’s students.

3.5 Path analysis

To summarize and to visualize the relationship among learner characteristics, learning practice and learning performance, path analysis was conducted using the Structural Equation Modelling (SEM) technique (McCloy et al. 1994, Kano & Miura 2002). The Optimized resolution was revealed by “CALIS” of SAS.
procedure (Toyoda 1992). This technique was considered as an appropriate analysis to visualize the path diagram and to understand the causal relationship among variables. SEM has already been conducted to create a model of relationship for the survey data (Nakayama et al., 2006), which was used as the framework for this analysis.

As a result, a path diagram was constructed using correlation matrix (Table 4) and causal relationship of variables. The path diagram consists of two parts and these are illustrated in Figures 5 and 6. The variables are illustrated as boxes, while the path is displayed as an arrow line. Path coefficient is shown on each path for the total population, and for master students and bachelor students respectively. GFI (Goodness of Fit Index) as total model evaluation measure is also displayed in the figures. The diagrams are appropriate because the GFI's are higher than 0.9 and significant without a condition for bachelor students in Figure 5.

Figure 5: Path diagram based on thinking styles and motivation for Bachelor and Master Students.

Figure 6: Path diagram based on conscientiousness for Bachelor and Master Students.
According to the diagrams, the key personal characteristics are CONSC, MOTIV and OLJ as part of thinking styles. Factor 1 (F1: e-Learning evaluation) takes part in the causal relationship and affects mainly NCM in both diagrams. NCM relates strongly with online test scores or OTS.

The path diagram between A-students and B-students were also compared, and their causal relationships are summarized in Figures 7 and 8. It is interesting that the strength of links is different between the A-students and B-students, for example, among A-students, OLJ mainly affects Factor 1 (F1: e-Learning evaluation), but for B-students, it mainly affects Factor 2 (F2: learning habits).

These results suggest that learner characteristics affect learning experience and learning performance. Also, learning skills and knowledge acquired by students have repeated effects on their own learning behavior. Students mature or transform as they go through the course. In this study, some effects of this maturation or transformation process were investigated by doing an analysis of learner’s characteristics and learning experience. Other factors could very well affect learning behaviour and performance, and factors such as one’s recognition of the benefit of online course could be crucial. It is therefore important to consider learner characteristics and learners’ overall e-Learning experience in the instructional design and in the learning support provided in online courses in order to optimize the learning benefits that students can gain from hybrid courses.

The details of appropriate support programs for online courses will be the subject of further study.
4. Conclusion

This paper examined the impact of student characteristics on learning performance, while various indices of learners were measured under regular hybrid courses in a Japanese university. Differences between bachelor and master students were also examined further.

There were differences in conscientiousness between students with final grades of A and B for both bachelor and masters levels. This suggests that one of the personality scores affects the final grade. The score on "learning strategy" for master students was higher than the score of bachelor students. Master students’ evaluation of their e-Learning experience also increased significantly throughout the course. Causal analysis was conducted using Structural Equation Modeling technique (SEM), and the results indicated that learner characteristics affected learning experience and performance. According to the results, transformation of learners’ behavior could have taken place during the course, and data analysis indicated that learning performance was affected by this transformation.

An extraction of more stable causal models and creating appropriate support methodologies will be the subject of further study.

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Implementing International Virtual Elementary Classroom Activities for Public School Students in the U.S. and Korea

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Abstract: In today’s global society, individuals with an understanding of different cultures that have the ability to apply this understanding to real world problem solving are more likely to become leaders. Preparing students for a global society is becoming a significant part of education. While many international online exchange projects have been conducted at schools to help expose students to the world and experience international collaborations, few studies have focused on both developing intercultural competence for elementary school students and discovering practical ways of implementing a cross-cultural exchange program into the public elementary school systems as well. This study, International Virtual Elementary Classroom Activities (IVECA), planned to explore how American and Korean students can develop culturally meaningful interactions through asynchronous online communications in a content management system (CMS), Blackboard; and investigate the factors or strategies useful for integrating IVECA into public school curricula. Data were collected using observation and interview methods, and also included reviewing students’ journals. The data analysis involved interpretive analytic induction. Findings indicated that IVECA (a) promotes students’ intercultural competence; (b) developed their social interaction skills both in the regular classrooms and the virtual classroom; (c) facilitated diverse students’ motivations for learning at school; (d) enhanced writing and reading skills; and (e) engaged learning disabled students in the classroom activities. Additional findings from this study indicate that (a) a systematic support system for teachers’ technology use and instructional design is necessary, and (b) school administrators’ positive perception toward cross-cultural exchange activities and their coherent connections between state learning standards and IVECA objectives are important. Further considerations are addressed and the different influences of IVECA on the U.S. students and Korean students and its implementation, which takes into consideration such influences, will also be discussed.

Keywords: international virtual elementary classroom exchanges, intercultural competence, cultural awareness, online content management system, technology integration strategies, instructional technology support system

1. Introduction

Two assumptions guided the design of this study. First, that public schools need to prepare students to become capable global citizens equipped with intercultural competence and, second, that experiencing different cultures through direct interaction with people in other countries can help prepare students to become competent global citizens. International Virtual Elementary Classroom Activities (IVECA) were created to provide intercultural exchange activities for students in the U.S. and Korea. In addition, the study was constructed to examine key factors in implementing IVECA into public elementary schools.

Through Blackboard, a web-based content management system (CMS), elementary school students in both the U.S. and Korea studied cooperatively. These students focused on cultural awareness - defined here as the “understanding of the variety and relevance of all cultures (Guiherme, 2002).” A class of 12 U.S. fifth grade students, a class of 33 Korean sixth grade students, their teachers, and the U.S. school principal participated in a nine-week pilot study concerning the implementation of instructional technology for developing students’ intercultural competence. By providing information and communication technologies (ICT) such as email and asynchronous discussion board, this project intended to identify the effect of the International Virtual Elementary Classroom Activities (IVECA) on learning in the U.S. The project also discovered the needs for developing further implementation of the IVECA. This study also examined the changes of students’ cultural awareness and intercultural skills, and explored how the interaction between students and teachers meaningfully influences this change and how the school systems can provide support in implementing the IVECA. The researcher collected data through interviews with students, teachers, a principal, students’ journals, online discussion board messages, and observations in the U.S. classroom, informal discussions with teachers, and relevant documents such as emails from teachers and teachers’ instructional materials. Using the interpretive analytic induction (Erickson, 1986), key assertions about program implementation and effects were developed. Since the researcher was physically unable to observe the Korean site, data resources from Korea were limited to interviews and journals; thus, only overall comparisons focusing on the different influence of IVECA on the U.S. and Korean sites will be discussed at the end of this paper in light of the conclusion of this study.
2. Literature review

The current global economy requires people to have communication competence dealing with information and knowledge (Nanclares, 2001). To educate our children to become “global citizens who preserve the variety and vitality of life” (Davis, 2005), educators and educational leaders are increasingly pressured to change the curriculum and learning environments (Davis, 2005; Leeman & Ledoux, 2003).

With respect to the condition of becoming a global citizen, many researchers emphasize the need for an awareness and understanding of cultural differences and their relevance to human interactions (Guicherme, 2002). Calling attention to intercultural competence, Davis (2005) points out that “in order to survive today’s complex world, people need to understand different cultures.... adjustment and positive attitudes toward different cultures prompts people to take active roles in the diverse society.” Researchers stress effective and appropriate communication skills in working with people from diverse cultures (Wiseman, 2001; Fantini, 2000). In other words, intercultural competence involves being aware of a diversity of cultures, positively adjusting toward the different culture, and communicating with each other with an open mind. In addition, researchers in the field of business stress the development of intercultural skills and the need to become culturally competent in the complex international marketplace (http://www.irc-international.com/index.html).

Stating that intercultural competence is a new requirement for diverse organizations due to the globalization of working life, Korhonen (2002) also suggests that the development of intercultural competence should begin as early as possible. Students’ intercultural competence can be obtained through enhanced cultural awareness and cannot be excluded from the critical educational goals in our schools (Lustig & Koester, 1993). Consequently, directly interacting and communicating with people from other cultures will be the most effective way to perceive and learn about cultural diversity (Fantini, 2000).

Online research networks such as Global School Net (http://www.globalschoolnet.org/GSH/index.html) and Schools Online (http://www.schoolsonline.org/whoweare/mission.htm) have conducted international classroom exchange projects through the Internet to provide students with international or intercultural learning environments using Information and Communication Technology (ICT). Despite considerable numbers of projects introduced by these organizations, it is hard to find either qualitative or quantitative research focusing on students’ intercultural competence development in the context of international virtual classroom environments. Instead, Schools Online released an evaluation report after performing a collaborative Internet project with three schools in Macedonia and one elementary school in Denmark. Simovska (2001) evaluated the project based on the categories of students’ collaborative participation, the use of Information Technology, peer consultants, and project organization. According to the report, the project was successful in terms of facilitating students to actively and cooperatively participate in school and community improvement projects. The study indicated additional research, related to administrative support and facilitation in public schools regarding international exchange, was needed.

However, specific plans or strategies for implementing such international online exchange programs into public school systems in different nations have not been studied sufficiently. Accordingly, discovering certain approaches to effectively integrate and implement online intercultural exchange programs into public school systems become important, since different countries have different public school systems. In addition, the desired approach should be addressed by considering ways to integrate technology into regular school environments as well as the international online teaching and learning systems.

Regarding technology integration into schools, many researchers pointed out the importance of the teacher’s role (Tearle, 2004; Richardson, 2000; Bird, 2001; OFSTED, 2002). The needs of effective support for teachers’ ICT use (Bird, 2001; OFSTED, 2002) are also noted. Dexter (2002) presented Educational Technology Integration and Implementation Principles (eTips) that are applicable to general school environments. In order to accomplish successful technology integration into schools, she addresses two main premises in the eTips. First, the teachers must play the role of instructional designer, planning the use of the technology and second, the school environment must provide appropriate technology support for the teachers in this role. Her emphasis that teachers should be able to design the use of technology into their instruction so that their students’ learning outcomes may reflect on their selection of technology is consistent with other researchers.

Richardson (2000) also emphasized that teachers should be able to integrate both technological and pedagogical aspects into their teaching. Accordingly, the school’s role should be to provide teachers with technical support that they can access conveniently and flexibly (William, 2000). The policy of access to technical support can be provided by administrative leadership. The National Center for Education Statistics (2000) described principal leadership as one of the most important factors affecting the effective use of
technology in classrooms. When understanding how technology can best support instruction and assessment, principals tend to provide teachers with sufficient supportive guidance (Kincaid & Feldner, 2002). Those studies contribute to developing fundamental factors and principles in integrating technology into schools in general; however, they do not demonstrate the concrete ways of integrating online teaching and learning systems with public school systems. Therefore, it will be necessary to explore how the roles of school teachers, administrators, and supporting systems of the school are transformed in an online teaching and learning environment that is integrated with regular classroom activities.

With regard to the online teaching and learning environment, many researchers have studied how to best support an online instructor’s teaching activities in terms of facilitating desirable outcomes in students’ learning. Incorporating the book, “Essential Elements: Prepare, Design, and Teach Your Online Course” written by Erbium, McIntyre et al. (2002), Harms et al. (2006) discusses three instructional roles – designer, teacher, and facilitator – of an online teaching and learning system, Virtual School, essential for successful virtual schooling. The designer’s role is defined as including two aspects: structural support and instructional strategies. Structural support is related to scheduling, planning, and managing necessary support. Instructional strategies are applied to provide diverse environments for supporting students’ learning activities. The teacher’s essential roles are to provide informational materials, to facilitate discussion, and to promote active participation. Lastly, facilitators are needed mainly to support Virtual school students in their local contexts. More importantly, facilitators provide an immediate, personal, face-to-face communication option; they can act as problem-solvers, mentors and friends. Although it is useful in planning Virtual Schooling in terms of assigning key role players, this discussion does not handle the issue of how to integrate virtual schooling into public schools’ systems.

2.1 Research question

- How do the teachers and students in two selected public elementary schools in the U.S. and Korea engage in culturally meaningful interactions involving cultural awareness and social interaction?
- What factors should be considered when implement IVECA programs into public elementary school settings in the U.S. and Korea?

3. Method

Qualitative research methods were selected in order to focus on culturally meaningful interactions found in the students’ activities in the context of international and virtual learning environments. Assuming that students’ meaning making and teachers’ role play will be influenced by school system and structure, this study examined the following: a) students’ behaviors b) teachers’ instructional strategies in integrating IVECA into regular classroom activities and c) school administrators’ roles under the school systems. The researcher played various roles that may be needed to manage this project, such as a virtual administrator, virtual assistant and or facilitator. Figure 1 shows this project’s contextual map depicting the interactions (arrows) among the role players and participants.

![Figure 1: Contextual map of IVECA project](image)
classes in the U.S. and Korea participated in IVECA based on weekly topics and activities provided through Blackboard.

3.1 Participants and research site information

American 6th graders (12 out of 17 students) in a public elementary school (School A) class and Korean 6th graders (33 out of 33 students) in a public school (School B) class were selected as the population for this study. Korean public-school students learn English beginning in 3rd grade, focusing on listening and speaking, and they begin to practice listening, speaking, reading, and writing in 5th grade. Thus, the 6th grade students were considered proficient enough in English writing for the exchanges.

The American classroom was selected based on the teachers’ level of interest in the study and her availability in the study period. The Korean classroom was chosen by selecting a school in the region – the capital city Seoul – with students of approximately middle-level learning achievement and reasonable written English skills to allow meaningful interaction through Blackboard. The volunteering Korean teacher’s interest level and availability were also considered. While the American class has two ethnic groups consisting of eight African-Americans and nine Caucasians, the Korean class is composed solely of Asian students.

The U.S. teacher (Ms. B) has four years of teaching experience, possesses a teaching certificate, and has taught in the school for three years. Ms. B also worked in the Peace Corps for a year before teaching at school A and has an interest in international education. The Korean teacher (Ms. H) also has a teaching certificate, but had only one year of teaching experience before taking her 6th-grade students this year. She taught Elementary English in the previous year and has received all necessary training for English education through a prestigious teacher’s college in Korea and an on-going training program; however, she is not confident in writing or speaking English with native speakers.

School A can use either 12 laptops or a computing lab once a week (one or two hours of internet access per week are possible). School B has two hours of computer lab and internet access every week. These two schools were connected through IVECA on the CMS Blackboard so that the analysis unit was the two classes’ interactions connected for this single case study. School A had a stricter policy for students’ Internet access than School B; the American students (in school A) were not allowed to access to the Internet without the teacher’s presence, while the Korean students (in school B) could enter the computer lab anytime and use the Internet connection.

3.2 Procedure and intervention

Korea’s centralized curriculum and the U.S.’s decentralized curriculum were examined common topics relevant to cultural issues were selected for the students’ activities. The suggested topics and activities are related to these cultural issues, and students performed individual assignments as well as group projects. According to the weekly suggested topics and activities, Ms. H designed weekly lesson plans for her English Class and Ms. B planned her Reading and Writing in English (replaced pseudonymously and hereafter referred to as RWE) classes. Blackboard provided relevant teaching and learning resources on the web. Although providing topics and suggesting relevant activities to accomplish the topics, whole lesson plans and complete teaching resources were developed by teachers in order to use their own pedagogical strategies for integration with their curriculum.

In this study, the researcher played a role in assisting with scheduling students classes, supporting technological issues, managing learning content and student activities on Blackboard, and mediating both school teachers’ communication. The researcher initially conducted 20 minutes of Blackboard orientation for teachers and 60 minutes for students. For about 45 minutes out of 2 hours of RWE class on every Thursday, students posted their projects on the Blackboard discussion board for Korean students to read; they also shared their feelings and thoughts regarding the Korean students’ project mainly during class or daily break time throughout the week. Students visited and used Blackboard at anytime and anywhere. While participating in these activities, the researcher asked students to write three personal reflective journals on the activities. Students were recommended to use multimedia products such as digital photos and video/audio clips for the postings, The researcher also assisted with producing and posting the pictures or video clips when needed.
3.3 Data collection and methods

The researcher, as an instrument of this study, was equipped with knowledge, skills, and experience on elementary education, elementary EFL education, instructional design and technology, technology implementation into a school, and technology support for instructors and students. The researcher possesses a bachelor's degree in Elementary Education from Seoul National University of Education in Seoul Korea and has six years of teaching experience in Seoul elementary schools. While teaching under the Korea Ministry of Education campaign, the researcher took charge in implementing the School Information Automatization System in her school and conducted research on a plan for elementary English education enhancement. In her Masters program in Instructional Technology in the U.S., the researcher studied the implementation of information communication technology into K-12 schools. This study examined the terms of nation's economic and social growth and determined the E-learn system as one of the desired educational systems for current and future societies. Through her comparative study on the needs for teachers to integrate technology in their teaching under the school system of both Korea and the U.S., the researcher built up a strong understanding of the different curriculums and school systems/policies in both nations. Currently, she is pursuing Ph.D. in Instructional Technology program in the U.S. and works at an Educational Technologies Offices of her school for supporting faculty and students' technology uses in their teaching and learning. Thus, researcher played roles as not only the research instrument, but also a technological and instructional supporter in this study.

Observation of U.S. student changes in cultural awareness and the influence of IVECA in their ordinary lives, involved observation of physical and virtual classroom activities, an informal discussion with Ms. B, interviews with students, Ms. B and a school principal (Mr. H), and reviews of relevant documentation including students' journals and pictures. The researcher mostly sat, wrote notes, and videotaped in the back of the classroom so as not to disturb classroom activities– all observations were recorded on both field notes and video files for multiple reviews. The researcher observed both the teacher and the students' noticeable behaviors and/or interactions, and simultaneously recorded classroom activities on notes and analytic memos (Miles and Huberman, 1994).

Interviews were recorded on digital audio files. Observations of virtual classroom activities were performed daily for nine weeks from 10 minutes through 120 minutes each day. Informal talks and discussions with Ms. B were recorded right after every weekly activity for 30 to 45 minutes. Seven total U.S. students were interviewed for 30 to 40 minutes each during and after this study period. In order to make students feel comfortable when talking about their thoughts and feelings, interviews were performed in empty classrooms, a meeting room at the library, or an empty school cafeteria after classes ended or before classes began. Based on observation, diverse types of students were selected for the interviews. A 90 minute interview was conducted with Mr. H after completing the study at the school.

Students’ journals were collected at the beginning, the middle, and the end of the study. Observation data including analytic memos and the transcriptions and analytic notes of interviews were rewritten on Excel. The rewritten data was then chunked by dates and contents in the Excel spreadsheets. Korean site data were collected from interviews conducted by researcher with 10 students and their teacher and from 33 students’ journals that are randomly submitted to the Korean teacher. Each interview with Korean students took between 40 minutes to two hours. These interviews were conducted on BudyBudy messenger (one of the Korean instant messengers that is popular among K-12 students) voice chatting after the IVECA activities ended, and a separate formal interview took place with a Korean teacher that lasted roughly 100 minutes via Skype messenger voice chatting. In addition, research also involved informal phone/email conversations with the aforementioned Korean teacher.

3.4 Data analysis

According to the analytic induction, (Erickson, 1986) method, all observation field notes, interview notes, audio-visual recordings, and reflective journals were reviewed multiple times in order to generate empirical assertions. To address the assertions and to affirm their validity, entire data corpuses were repeatedly reviewed to find supportive and non-supportive evidence for the assertions developed. The evidence was systematically examined by looking for frequently occurring patterns and coherent changes in participants’ interactions and reflections. It was determined by organizing them according to meaningful items linked to conceptual frameworks of this study. The Excel program was used for linking the items to the data written on the excel spreadsheets, sorting out the items, and finding patterns. Key assertions were identified through the generalization of the items within the cases of school A and B. After contextually looking through the positive effects of the study and their possible causes, this study determined the vital factors for
implementing IVECA into a public school. The constructed assertions will be listed below as statements concerning how IVECA activities influenced students’ learning and school life. Summaries of quotes from collected data, which will be elucidated through interpretive comments on the quotes, will accompany the constructed assertions. The teachers’ implementation strategy and its relationship with the school administrator and school system will be depicted through short summaries of the quotes from the interviews with the teachers from both schools and the principal from school A.

To enforce validity, the researcher put efforts on collecting rich data through videotaping of observations, audio recording of interviews and verbatim transcribing of them. Supporting and the discrepant data were examined through diverse data, and various types of students were selected for interviews and continuous discussions with the teachers about their students were performed to reduce bias. In addition, through the discussions and interviews, feedback on some of the conclusions of this study and suggestions were asked to the teacher and school administrator.

4. Findings

Assertions developed through analyzing the data collected from the U.S. and Korean classrooms are listed below, and some of the evidence will be provided. Quotes were directly excerpted from students’ writing and speaking so that some grammar or spellings would be wrongly displayed.

4.1 IVECA helps both motivated and unmotivated learners effectively discover different cultures and enthusiastically explore new and unknown learning opportunities through virtual interactions.

There were engaged (motivated) and disengaged (unmotivated) students in learning and both types of learners valued this project as an effective opportunity to obtain knowledge about a country on the other side of the world. These students also learned the value of each respective culture and their traditions directly from the students living in either country. Students who enjoy learning at school appreciated IVECA as an effective way of obtaining knowledge about other cultures:

- “This is cool because I learn from people in Korea. Just like us, we are talking with them and learning their culture, food, clothes…”

In addition, students who were having problems learning and/or concentrating in school or had been suspended from school showed positive reactions toward IVECA through the Blackboard discussion board and interviews:

- “I think there are many things that I can learn in your country… I would like to hear more about your folk tales next time.”
- “(Before the IVECA project) All the time same schedules…same teachers, same subjects, doing same things everyday… (During the project) I feel pretty good! I am thinking what to write today on Blackboard, what Korean students wrote, and how they are doing in Korea…It’s really fun to think about. It is very different from other classes… It is interesting they wrote. Those are very new I never heard before….Oh yeah, I wish I could do this all---the time, e---veryday.”

While most Korean students were excited about the project, regardless of their learning levels, some students were concerned with two aspects at the beginning of the project: their English skills and time-consumption. However, most students eventually appreciated IVECA since IVECA not only improved their English skills, but also made them enjoy using English: particularly, while learning new information directly from American students:

- “It was amazing that I learn something new through IVECA.”
- “I never knew communicating in English can be so exciting like this. This is good because you can ask each other to get information although you are not good at English.”

4.2 IVECA promotes students’ acknowledgement of cultural differences and similarities by helping them become aware of their own culture as well as others’

Students in the U.S. became aware of the cultural differences between Americans and Koreans while exchanging information. When introduced to certain Korean customs or traditions from Korean students, American students introspectively became inquisitive of not merely Korean culture/tradition, but also their own culture. Consequently, IVECA, through direct interaction and communication, allowed them to realize how different these cultures are:

- “I have thought about my culture but it’s way different from theirs!”
“I like this project because it let us talk about our country to another country. I think it is very interesting to see and hear about different other country’s cultures and customs.”

It was observed during their own classroom exercises that American students recognized similarities between the two cultures such as family-gathering and preparing special foods for Holidays, etc.

Korean students seemed to put more effort on posting correct and sufficient information about their culture and society, and they seemed to appreciate their own culture, language and nation during the activities. In addition, they felt more comfortable communicating with American students by gradually realizing that American students’ school life and their ways of thinking were similar to theirs:

- “It’s good that I am learning too while introducing my country to America.”
- “Through these activities, I feel that I should know well about our country and language.”
- “They are just like us… their interest, classrooms… so I started feeling easy about writing”

5. 3 IVECA improves students’ intercultural competence in terms of displaying openness to the world, showing positive affect toward the other culture, obtaining communicative strategies, and being mindful of other cultures

It was observed that students began to think more openly about the world throughout the project. At the beginning of the project, when asked about their perception regarding visiting or exploring other countries, students commented that they had not thought about traveling abroad, save a few students that had family members overseas or whose parents came from different countries. While these students were thinking of leaving the country, they were most interested in visiting the country/countries where their family members or parents lived. However, after the second and third journal entries, students began to look upon other cultures positively. In fact, the same students showed more interest and were more open to places beyond where family members lived and to the world, writ large. Above all, the students’ became more curious about places throughout the world:

- “I want to interact with more than one culture, so maybe one or two or even three, like Romania, Italy, and or Africa.”
- “One day I would like to go to Korea… I would like to talk to younger kids from a different country”.

Because of the language barrier between Americans and Koreans, the students began to understand English in a unique way. Although Korean students sometimes wrote English awkwardly, American students - that also did not yet have a firm grasp on the English language - gradually found their own way of understanding the Korean version of English. This was most likely influenced by the fact that Korean students, when communicating their American counterparts, wrote English in a different manner. Students demonstrated how IVECA naturally helped them to attain a communicative strategy:

- “I didn’t like about it (at the beginning), which is not being able to understand what they wrote. It is kind of hard to understand them. But, I think over the time I get used to it I pretty much understand them.”

She said she picked the words from Korean students’ messages and guessed at what they were trying to say. This strategy was also obtained by Korean students:

- “I realized that I was reading English without spending lots of time at the end. I was just reading through the messages and I thought I mostly understood.”

4.3 IVECA provides opportunities to extend social skills for learning disabled students

A student with Asperger’s Syndrome took advantage of IVECA to build a good friendship through social interactions. Autism Spectrum Disorder (ASD) is “a developmental disability that impacts the normal development of the brain in the areas of social interaction and communication skills”, Asperger’s Syndrome is “a form of autism where the child has fewer developmental delays, and their repetitious behaviors may be
more subtle.” (http://www.kylestreehouse.org/what_is_autism.cfm). The virtual environment with asynchronous discussion boards helped the ASD student communicate comfortably with friends since the counterpart students could neither hear or see the student with ASD. Jim (the student with the syndrome) described how he found communicating with Korean students via IVECA compensated for his poor relationship with physical classroom friends. Jim states,

“I don’t want to be known on the eastern side of the world as a not. I want to be known on the eastern side of the world this Jim will solve the future and offer well-life center keeper… There are many mistakes and underestimation in school… I DO care (about others’ bad ways of treating him)... The benefit of this project is meeting people cross the world. I mean it’s great thing to know friends so far off but it’s really great you won’t be able to see…. You won’t be able to judge person by the cover. And it will make to see inside and it won’t be as hard as to see outside.”

4.4 IVECA develops students’ writing skills by providing opportunities to write for ‘real’ audiences

Since the students have a real audience that actually reads and may potentially respond to what respective students have written, students realize the importance of being aware of the audiences’ positions and expectations in their writing. For instance, an American student explained her consideration in writing:

“(Before writing) I think what kind of writing they are using there…. how they understand our writing… Maybe I think it will be good to use right grammar for them because they might learn with books....”

In addition, both nations' students became more interested in writing because computers allowed them to share their writing electronically with audiences from other countries that directly provided responses and feedback. Students commented,

“Makes me feel like, Hey, I am sending part of my genetic code over the world, part of my thought!”

“I write a lot to Korean students with a computer. I like it because they are gonna read what I wrote and we are talking about it.”

“I really wonder what American students will respond to our postings. Oh~ I cannot wait to see them!”

4.5 IVECA serves as a pacing guide and teaching resource for teachers, fitting well within the system of decentralized U.S. curriculum

This IVECA structure helped Ms. B (American teacher) save time for creating a separate unit plan, or select the whole contents for IVECA, as they would normally do for their regular classes under decentralized curriculum system. Ms. B. could focus on designing each lesson because IVECA provided topics and suggested activities incorporated with RWE curriculum. In addition, the virtual administrator (researcher) adjusted teaching paces when each school had special events by mediating communication between the American teacher and the Korean teacher. Since IVECA's predetermined teaching plans helps teachers design and integrate their respective curriculum into classroom activities, other teachers expressed interest in IVECA informally with Mrs. B. teachers’ interest in IVECA.

Because of the language barrier and Korea’s centralized curriculum system strictly regimented, Korean’s could not devote as much time to IVECA as their American counterparts. For instance, Ms. H. was able to integrate IVECA into her other subjects hours since the IVECA topics and activities are related to certain parts of the subjects (such as, social studies and Korean language). However, Ms. H (Korean teacher) commented that she needed more time to prepare her students in reading and posting messages, but she only had limited subject hours and teacher-discretion time to devote to IVECA exclusively.

4.6 Technological and instructional support systems are demanded

The teachers needed a technological assistant throughout the study. For example, although the creative idea of exchanging role-play activities with counterpart students was suggested by teachers, the researcher made it happen by providing technological support, such as producing appropriately sized of video clips of students’ role-playing.

The researcher observed that both teachers needed additional skills for teaching online: particularly, facilitating students’ activities and providing a sense of community, preparing instructional materials on the
web, giving appropriate feedback, etc. Ms. B commented in the interview that she desires to learn more about how to manage multimedia production and online teaching tools on Blackboard. She urged that technological proficiency would give her more freedom to design diverse lessons and effectively direct and facilitate students’ activities.

4.7 School administrator’s understanding of IVECA influences teacher’s effective implementation of IVECA: School administrator’s understanding consists of making meaningful connections among his school goals, his educational philosophy, and the role of the IVECA

The school principal, Mr. H, believed IVECA was an innovative method for getting his students to reach the school’s curricular objectives. He further stated, that IVECA’s innovative methods encouraged teachers to integrate technology into classroom activities. According to Mr. H., the goal of school A is to help students become knowledgeable and productive citizens that are capable of understanding, managing, and solving diverse problems in a multicultural society. From the principal’s perspective, the way to achieve this goal is to support teachers in promoting students’ intellectual, physical, and social development: especially, by providing additional learning experiences beyond the school’s walls. Mr. H. insisted that this is his mission for school A. In terms of expanding the experience to the world, Mr. H expressed that he found the IVECA program fits with the school’s mission as well as the RWE curriculum. His positive understanding of IVECA led to cooperative discussions between himself and Ms. B about more effectual implementation measures. As a result of Mr. H.’s positive response to IVECA, Ms. B, asked for more laptop computers. On the contrary, the Korean administrator did not actively participate in IVECA’s implementation. Consequently it was often observed that the Korean teacher had problems implementing IVECA into her classes. Ms H. found it difficult to arrange computer lab hours and to discuss effective ways to integrate IVECA into her teaching.

5. Discussion and suggestion

The findings will be discussed in light of two main purposes of this study: exploring the influence of IVECA and determining key factors that need to be considered for IVECA’s implementation. Also, each discussion will be followed with comparative comments about the results from Korean site data, which will be discussed to suggest further research methods.

5.1 IVECA’s influence on an elementary school classroom

Fantini (2000) noted “while acknowledging that contact and experience with people of other languages and cultures in a positive setting provides excellent opportunities to provoke and foster intercultural (communicative) competence development, it is also clear that once the process has begun, intercultural competence development is an on-going and lengthy — often a lifelong process.” This study certainly proved students’ progress in developing intercultural competence that appeared in the first journal entries and grew throughout the project. As the IVECA project went on, students frequently displayed their curiosities and interests in interacting with people in diverse cultures. Additionally, both nations’ students expressed their desire to meet and talk with the opposing country. This openness to the world and the positive affection toward other cultures are frequently referred to as one of the major topics in researching intercultural competence (Wiseman & Koester, 1993) and this study showed that the openness and fondness toward the world have been fostered by participating IVECA.

Obtaining communicative strategies of understanding diverse types of English has been emphasized as one of the intercultural competences that students should be equipped with (Guiherme, 2002). Results from this study showed that students gradually developed the communicative strategies through IVECA. Both students demonstrated that understanding each others’ writing somehow became easier. In particular, Korean students’ biggest focus was on using English for IVECA and stated that IVECA enhanced their English skills, helped them feel confident about using English with native speakers, or motivated them to study English harder. This indicates that IVECA naturally provides students with the opportunity to attain the communicative strategy and boosts their motivation for learning English. This result also proves Daoud’s study (1998) that cross-cultural exchanges motivate EFL learning and improves writing skills.

Being able to enjoy and contemplate the reasons why some people talk or behave differently is also one of the significant elements of intercultural competences (Kelley & Meyers, 1995). According to Thomton and Mcentee (1995), through being mindful, “students create new categories in identifying, naming, or thinking about self, others, and situations, which help them to acknowledge the possibility and existence of equally legitimate other ways of viewing the world.” They say that, thereafter, students gain awareness of more than
one perspective that is one of the “key qualities of a mindful state”. IVECA helped American students voluntarily take others’ positions and discipline themselves to be decent and mindful about others’ feelings through their considerations of different cultures and situations. Reversely, some of Korean students’ were cautious about communicating with American students because they assumed that American students might be annoyed at Korean students’ poor English. However, they tried to identify themselves as American students in order to understand native English speakers’ point of view and realized that American students think and feel similarly to them. By being mindful, both nations’ students were able to reflect others’ perspectives and achieve thoughtful understanding of each other.

Students’ interest in reading and writing about culture intensified through IVECA participation. Liu (2002) discovered the fact that international pen-pal writing through the Internet increases motivation in literacy learning and enhances cultural awareness. By providing quasi-pen-pal writing experiences that students can not only share their classroom activities, but also personal interests such as hobbies and school life, IVECA contributed to developing awareness and engaging students into English learning at school. In addition, most students showed positive attitudes toward using computer in their writing and it affected their “wiring motivation, communication, empowerment, and learning” (Warschauer, 1996).

This study also revealed that IVECA not only engages diverse students in different learning achievement levels, but also helps a child with Asperger’s Syndrome (a kind of ASD) enjoy social interactions with friends overseas since the virtual environment provides more predictable and prepared interaction opportunities without having face-to-face encounters. According to Dautenhahn (2000), “children with autism prefer a predictable, structured and in this way ‘safe’ environment” where they can control their interaction. Throughout the study, the American student with Asperger’s Syndrome showed that he favored the fact that Korean students could not see his face, and he displayed his cautious attitude when writing messages to Korean students. The value of IVECA was discovered in that its system and activities engage diverse types of not only normal students but also a socially disabled student.

5.2 Key factors for effective implementation of IVECA

Teachers’ lack of time in designing instruction and planning technology uses in the instruction has been pointed out as one of the significant barriers for implementing educational technology into classroom (Dexter, 2002; Tearle, 2004). The structured IVECA program contributed to reducing the American teacher’s planning hours at school. Since having flexibility in scheduling the teaching units and selecting contents, the decentralized U.S. curriculum makes it easier to incorporate IVECA with local school RWE curriculum. However, the Korean teacher had difficulties integrating IVECA with her regular classes under centralized curriculum system. That was because the pre-determined contents of Korean school’s curriculum were not replaceable with that of IVECA, and students needed more time in completing IVECA assignments. Although her professionalism was displayed by applying some of the activities into Korean Social Studies classes, IVECA could not reduce Korean teachers’ time-consumption. Thus, the researcher as the virtual administrator and assistant had to provide more instructional support for Korean teacher. This suggests that future research should provide teachers with effective and necessary virtual administration and the appropriate amounts of weekly activities that fit in both systems of decentralized and centralized curriculum system. That is because the individual members can positively observe the innovation process after their acceptance of the new idea,(Roger, 2003). The supportive communication between the American principal, who connected IVECA goals with school goals and provided flexible access to technology, and the American teacher who employed IVECA, reinforced IVECA’s implementation into the classroom. Yet, the Korean school did not have a similar relationship due to the Korean school principal’s lack of participation in the IVECA project.

Educational technology can be successfully integrated into classroom when schools provide effective access to supported technology (Bird, 2001; OFSTED, 2002; Dexter, 2002). School administrators’ understanding about the advantages of using technology in teaching-and-learning can influence schools’ technology policies (Kincaid & Feldner, 2002). Effective communication channels in a system facilitate and maintain diffusion of a certain innovation. That is because the individual members can positively observe the innovation process after their acceptance of the new idea,(Roger, 2003). The supportive communication between the American principal, who connected IVECA goals with school goals and provided flexible access to technology, and the American teacher who employed IVECA, reinforced IVECA’s implementation into the classroom. Yet, the Korean school did not have a similar relationship due to the Korean school principal’s lack of participation in the IVECA project.

Teachers were most concerned about technological issues that arose when American and Korean students communicated: particularly, the utilization of multimedia tools and Blackboard functions. The teachers’ questions were usually premised on the utilization of multimedia tools and Blackboard functions that need to be used when American and Korean students to communicate. It showed that teachers need instructional
guides as well as technical support in order to integrate technology (IVECA) into their classrooms (Ronkvist, 1998). William (2000) identified training and on-going support as one of the needs for teachers in successfully integrating technologies. Consequently, this study suggests that future research should provide professional development programs that teach teachers how to use classroom technologies (CMS and multimedia tools) and equip them with instructional strategies. In addition, discovering supportive resources in existing public school systems and reorganizing their roles for virtual classroom activities should enable and subsequently maintain teachers’ integration of IVECA into local school curriculum.

Based on the development of the study and its finding, a model has been developed that will be used to guide future research. In the model, the virtual administrator’s role is to establish communication between U.S. and Korean teachers by scheduling and adjusting each class. Virtual administrators will also consult exchange activity planning with both teachers. The role of the virtual assistant is to help both teachers assign projects and give feedback to their students. The administrator in each school takes the role of linking the activities to the school’s goal and to provide technical support as needed. Through virtual exchange activities, eventually, students will obtain intercultural competence and become well prepared, contributing global citizens. Teachers will crucially influence the project’s utility by effectively integrating IVECA with their local classroom activities. Teachers’ activities will help their students achieve IVECA’s primary objective of helping students become inter-culturally competent, through IVECA activities.

This study explored how IVECA influences elementary students and teachers in the U.S. and Korea. It discovered significant elements that should be considered for IVECA’s effective integration into a small unit: a local school curriculum and system in two nations. By testing the IVECA implementation model briefly described above, future research seeks to prove the feasibility of integrating IVECA into a larger unit scale.

References

Lecture Recording: Structural and Symbolic Information vs. Flexibility of Presentation

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Abstract: Rapid eLearning is an ongoing trend which enables flexible and cost-effective creation of learning materials. Especially, lecture recording has turned out to be a lightweight method particularly suited for existing lectures and blended learning strategies. In order to not only sequentially playback but offer full fledged navigation, search and inspection of the recorded lecture, chapter marks and search indices have to be embedded. To solve this, two basic approaches for lecture recording tools can be identified - both of them having certain advantages and drawbacks. On the one hand there are systems based on symbolic representation of common slideshow formats like MS PowerPoint. Therefore, they preserve structure and symbol information contained therein, but are lacking flexibility of supported dynamic and interactive formats. On the other hand there are systems based on pixel representation and screen grabbing technologies. While supporting any presentation content, structural and symbolic information cannot be extracted directly and thus has to be post-processed from the recorded video. This paper discusses a perspective of combining these approaches by widening the slide-metaphor to a more flexible scene-based presentation, preserving both the structural and symbolic information. One possible attempt for this is identified by introducing a browser-based scene concept. Symbolic information can be directly extracted from the XHTML source code and structural information derived from switching through scenes. The browser itself is capable of presenting a wide range of dynamic and interactive formats, thus offering more flexible presentations. For approving the proposed concepts, a prototype called “Virtual Overhead” was developed and evaluated.

Keywords: rapid e-learning, lecture recording, lightweight content production, browser interactivity

1. Introduction

With the increasing availability of computers and growing bandwidth of internet connections technology-enhanced teaching and learning scenarios have shifted from research projects to wide spread usage. This results in the need of easy and cost-effective approaches and tools for content creation. Traditional development processes for eLearning content are quite complex and cost-intensive – ranging from 50.000 to 100.000 EUR per lecture hour (Lauer and Ottmann 2002) – and teams with expertise from different domains are required. Rapid eLearning (REL) strategies try to reduce this effort. Basically, these approaches have in common, that the subject matter expert (SME) is solely responsible for content-creation. In this he/she is assisted by special authoring tools, which include templates for both instructional and screen design. By abstracting from programmatic aspects no additional technical knowledge is needed. This approach reduces development cycles and costs, sceptics argue it also reduces the quality of the final learning content.

Lecture Recording is one particular REL-concept for cost-effectively creating learning content. By recording and transmitting face-to-face lectures or presentations, synchronous online attendance for distance learning is enabled and moreover lectures are preserved for later asynchronous playback. Especially suited for blended learning strategies, Lecture Recording is a way to elegantly combine traditional and technology-based learning scenarios. In addition it provides versatile digital learning materials at negligible additional costs and therefore can be described as lightweight content production (Kandzia et al. 2004).

In order to acquire every relevant aspect of the live presentation, three basic streams have to be captured. First and foremost, the teacher’s verbal narration which accompanies the slides or visual presentation. These two sources are considered being essential streams, whereas the live video should neither be overestimated nor underestimated in its importance for learning (Lauer and Ottmann 2002). The presenter’s video gives an impression of his presence and serves for improving authenticity, but conveys comparatively little information in most cases (Schütz 2003). The more expressive the lecturer’s gesture is, the more valuable the video gets for learners. In summary a modern system for lecture recording should integrate capabilities for dealing with video, as its importance will increase for bridging perceived gaps in distance learning.

In order to emphasize certain aspects of the visual presentation, a lecture recording system should integrate options to superimpose annotations like freehand drawing or rectangles over the content. In higher education and universities typically an electronic lecture of about 90 minutes is produced. Hence providing only
sequential playback does not serve the learners needs, especially when used as additional material for preparing tests and exams. Instead users want to easily navigate within the electronic lecture (Zupancic and Horz 2002). Therefore common controls like play and pause should be completed with random access via timeline navigation controlled by a visual slider. Furthermore specialized interface controls make sense for replaying the lecture at a different speed while maintaining pitch. Hürst presents such a novel way of audio browsing with an elastic slider controlling the speed of replay (Hürst et al. 2005). Moreover learners need to directly locate and access certain points, like chapters or individual slides. For this timestamps or indices are used, which have to be embedded in the lectures media files and user interface. Additional posterframes corresponding to the timestamps can further simplify visual selection of relevant portions. In order to enable users to inspect the lectures content rapidly, search and retrieval features are required. Prerequisite for both navigation and search is the ability of the recording system to access and gather relevant symbolic and structural metadata from the presentation’s content. This requirement and its relation to the flexibility of presentation offered by the system is the key aspect of this paper and is further investigated in the remaining parts.

2. Lecture recording approaches

To facilitate the identified features of navigation and retrieval, the process of capturing the presentation’s content is of critical importance. While the recording of audio and video stays the same for different approaches, concepts of existing systems vary a lot regarding the visual presentation. Early suggestions were based on simply recording a blackboard or overhead projection with video cameras, which inevitably lead to unacceptable quality of the presentation (Lauer and Ottmann 2002). In contrast, modern lecture recording systems are part of an all-digital-environment and therefore can be grouped into different categories, regarding the representation of content (Ziewer 2006):

1. Symbolic Recorders (input grabbing)
2. Screen Recorders (output grabbing)
3. Hybrid Systems

2.1 Symbolic recorders

Symbolic Recorders (figure 1) make use of a priori knowledge concerning the presentation’s input to obtain needed metadata for navigational indices and search functionality. These systems directly store content in symbolic representation, which has to be interpreted during any replay. Hence, a special player software has to be used, which makes it possible to adapt playback to different devices. Textual symbol information of every slide is included in the final lecture media and enables searching. Events like switching through the slides of a presentation trigger the recorder to set timestamps for playback and slide-based navigation.

According to this, symbolic recorders must at least have a connection to the presentation software in order to receive this information. In most cases they are tightly integrated with the presentation software, thus vitally depending on it. Particularly, the flexibility of the presentation’s content is determined by the presentation software.

![Figure 1: Symbolic recorders](image)

2.2 Screen recorders

In contrast Screen Recorders (figure 2) are fully independent of the presentation content and software. They get the visual output by either directly grabbing the computer’s graphics buffer or its output via a VGA-grabber card. In return they do not have any prior information to directly derive required navigational and retrieval metadata, which has to be extensively post-processed from the recorded video stream. This independence in turn results in virtually unlimited flexibility of presentation. Besides conventional
presentation software, every other program can be executed and recorded, which is especially useful for simulations, programming exercises and other sophisticated applications.

Figure 2: Screen recorders

2.3 Hybrid systems

Hybrid systems (figure 3) combine key aspects of these two approaches. While grabbing the visual presentation’s output (screen recording), connecting this recorder with the presentation software directly provides symbolic information for searching and timestamps for navigation (symbolic recording). This concept permits mixed usage of the designated presentation software together with any other software. Of course derivation of navigation and search metadata is limited rather strictly and basically only covers the presentations software’s content. Equal to pure symbolic recorders the presentation software of hybrid systems determines which input formats and features are supported to offer full derivation of needed metadata.

Figure 3: Hybrid systems

2.4 Comparison

A comparison of the concepts described above regarding metadata and flexibility of presentation shows that screen recorders offer the most flexible features for the lecturer but at the cost of metadata. While this information can be retrieved from the screen video by automated character/text recognition and slide detection (Ziewer 2004), such solutions are quite complex and results are not as reliable as directly extracted metadata. In exchange indices are collected for virtually any content including images, videos and animations. In contrast symbolic recorders offer high quality metadata at the cost of flexibility of presentation. Only features incorporated in the presentation software itself are supported. In summary, hybrid systems trade off drawbacks and advantages of both concepts by offering directly extracted metadata and usage of external software as well. Therefore this approach is especially suited for further investigation.

2.5 Integrating and controlling external content

Flexibility of presentation is the most important aspect for the SME when designing course content. But when it comes to actually giving the lecture, this flexibility has to be accompanied by means of structuring, arranging and coordinating various content sources. Common presentation programs like MS PowerPoint serve this requirement well by dividing the lecture into small segments called slides. They contain diverse media elements and can easily be presented successively. But unfortunately this kind of software has quite restricted support of input formats and aims at little interactivity during presentation (section 3).

In the previous section the concept of a hybrid system was selected, because it permits the lecturer to step out of the presentation software and use arbitrary software to augment the lecture with additional elements. But in doing so, the instructor is solely responsible for preparing every content source before the lecture and managing the lecture’s progress by selecting and advancing to the appropriate external content. As this has to take place in real-time and parallel to verbally explaining the lecture’s subject, certain pitfalls are inherent
to this approach. For example, a lecturer using web content might get “lost in cyberspace”, because the URL must be typed in or a link has to be placed somewhere. In addition, switching through applications causes visual discontinuities which in turn provoke irritations for learners, not knowing what to concentrate on. When several external applications are used, the instructor may have to switch through them in search for the intended one. Effects like these are challenging for both the instructor and the learners as soon as external sources are used more than occasionally.

In summary, neither existing presentation software provides enough flexibility, nor are external sources and software easy to control and integrate into a conventional slideshow presentation. To overcome this, it is desirable to give the lecturer options to control the presentation’s flow in a concise and consistent way. To achieve this, integrating extended features into the presentation software seems to be necessary, most notably interactive features. In addition, this approach renders even more sources accessible for direct metadata-collection in a hybrid lecture recording environment (figure 3), like extracting from XHTML-source code.

3. Browser-based presentation software

Modern slideshow presentation software in fact supports a vast number of media formats for audio, image and video assets. In addition a lot of assets can be created within the software itself, ranging from simple objects (lines, rectangles…) to complex flow charts. Even some limited animations can be set for visual elements and slides. But the overall design of slideshow software is originally focussed on static content for text- and image-centred (business) presentations. It therefore does not stretch out to comprehensive interactivity. For example, it is not intended to directly display PDF-content (like scientific papers) or to control parameters of interactive graphics. Moreover, web resources and services cannot be included directly, instead the presenter has to make screenshots and manually embed them into the slideshow. Or a dedicated browser has to be used for this, leading to problems of managing and controlling the lecture’s flow between the presentation itself and multiple external sources (as described in section 2.5). In addition desired metadata for navigation and retrieval cannot be extracted when using external browser software in a hybrid lecture recording system (section 2.3).

However, a modern web browser is capable of loading and displaying content of numerous formats and standards, either directly or via plug-ins. The support for audio, image and video files is comparable to conventional presentation applications. As common slideshow presentations can be exported to popular image formats, existing content can be imported and reused, although dynamic content gets lost. Indeed, experience shows that few presentations actually use these features beyond fading-in bullet lists step by step or slide transitions.

Due to browser plug-ins even future file formats and standards can easily be displayed without modifying the presentation application itself. The overall extensible architecture of browser engines allows sophisticated content like Java-applets to incorporate specialised elements suited for teaching purposes. For instance in mathematics or physics education interactive graphs of functions are often used and can be modified by controlling certain parameters. In contrast to slideshow applications browser-based software is ideally suited for this kind of purposes. Together with the trend of rich internet applications (RIA) and the upcoming “Web2.0”, the browser’s role and importance is expected to increase for almost every aspect of technology enhanced work and learning in particular. In conjunction with the hybrid lecture recording approach, it is sufficient to display the content, as the screen grabbing process merges several formats into the selected format for publishing. Thus, learners only have to support this final format and are independent of the presentation’s original input. Nevertheless it is desirable to give students access to the majority of learning materials for self-paced learning (especially interactive content), which can be accomplished by web-publishing in widespread formats. In return, these materials can be directly integrated into browser-based presentation software.

Together with these benefits towards flexibility some disadvantages result from using a browser-engine. At first there are known incompatibilities of browsers concerning display of standards (like Cascading Style Sheets) and every rendering engine handles content a little differently. Moreover images, which are intended to display full-screen, have to fit exactly into the browser’s view-port. Thus, they have to be created with these dimensions, for instance when exporting PowerPoint slides. Compared to these drawbacks the advantages seem to be more important.
4. “Virtual overhead”

By developing a prototype the suitability of a browser as a presentation software engine should be proved. But instead of just exchanging common display engines for a browser, further flexibility enhancements were aimed at. Therefore, a different guiding metaphor to “slide” was identified and shaped to match the requirements of instructors and lecturers.

4.1 Enhanced scene metaphor

Besides integrating suitable features and web-support into a conventional presentation program, a browser engine can straightforwardly serve as the basis of alternative presentation software. Although this approach cannot replace every external application, it can substantially expand the flexibility of the presentation software. To offer more interactive flexibility, basically the slide-metaphor of existing application can be widened to a scene-metaphor. A scene is the adoption of terms originated in theatre and film production. It consists of a stage populated with actors playing certain roles coordinated by the director. Scenes differ in background/setting and actors and intentionally have a dynamic and active character. Because of these attributes the term “scene” seems to be better suited for describing properties of the intended interactive and dynamic presentation segments.

Applied to browser-based presentation software, a scene is like a browser “tab” or window – a viewing port for any supported content obtained from a URL. If static formats are loaded it is equal to an ordinary slide, but in case of interactive content it can be freely manipulated, exposing rich features for teaching purposes. When preparing a presentation, scenes can be added and directed to a specific URL, which not necessarily has to be on a remote server but as well can be a local file. During the presentation, scenes are progressed step by step equal to slides.

Beyond using a browser-engine as basis, a scene concept suggests additional modifications of presentation application design. In most teaching situations questions of students lead to further explanations demanding space for additional freehand-drawings or references to supplemental materials. For instance, the instructor queries “Wikipedia” or “Google” concerning a topic arising from a student’s request. As this could not be anticipated during preparation of the presentation, a new scene has to be created at lecture time. This flexibility strengthens the usage of a scene-metaphor even more – analogous to improvisation in theatre performances. This concept is followed throughout the overall design. From this point of view scene-based software should be modeless, so there is no difference between authoring and presentation (in contrast to common slideshow applications). This allows to give the presenter full control over the presentation’s relevant parameters during the lecture.

The design of the annotation feature is closely connected to this modeless approach: It is modelled as a layered stack of elements on top of the scene content. In fact the annotations mirror the basic elements for static slide content, including freehand pen drawing, formatted text boxes, geometric primitives (rectangles, circles) and image support – all annotations provide alpha channels for transparency. Every element can be dragged independently enabling recomposition of scenes even during presentation, if the need for further variation arises. If the scene’s content is scrollable, the annotations have to stay aligned with it. (Imagine a lengthy explanation by “Wikipedia”, where only a paragraph of the last part is relevant to the lecture’s topic and therefore was previously highlighted with a coloured box.) Moreover, the lecturer can easily drag & drop elements onto a new scene from a library of previously created/imported annotations. This concept allows slides to emerge visually and dynamically at presentation time instead of just switching, which is capable of focussing attention of learners to the process. This technique can be compared to a magnetic whiteboard with sets of adhesive icons and is often used in analog teaching scenarios. Because annotations are part of the scene, they disappear when scenes are switched, are made visible again when returning to that scene later during presentation and are even saved together with the presentation.

In conclusion flexibility of presentation is augmented in three aspects by applying a scene concept. At first, a browser-based scene can contain far more interactive content (JavaScript, Flash, Java-Applets, RIA ...). Second, a modeless design offers full control to the presenter, even to add new scenes while giving the lecture. Third, the visual elements of the annotation layer completely mirror static slide elements and are freely drag-able during presentation.
4.2 Application design

In order to validate the concept of browser- and scene-based presentation software, a prototype called “Virtual Overhead” was developed. Furthermore, the goal was to combine this presentation software with a screen recorder according to the hybrid lecture recording approach identified in section 2. To reduce development time and to access special features, the prototype was implemented on Apple Mac OS X, which offers an easy-to-use and yet flexible programming environment, including a browser engine (based on Konqueror’s KHTML engine) and far-reaching OpenGL support for screen grabbing. A straightforward Model-View-Controller (MVC) pattern was used to implement the system (figure 4). A “project controller” mediates between the primary model class (“project”) and related functionality. For instance, it adds or removes scenes and responds to switching scenes. A “project” itself contains an array of “scenes” together with additional information (imported/created assets, bookmarks etc.). In turn, the “scene” is basically composed of a browser view-port associated with an URL and a stack of “annotation” items. All annotation elements (freehand, rectangle, etc.) are subclasses of a virtual “annotation” class. The internal state of a “scene” is managed by a “scene controller”, it adds or removes annotations and redirects the URL associated with a scene. Finally a “tool controller” coordinates the function of the pointing device, whether the user is actually drawing, moving annotations or interacting with the browser’s content. Moreover, it is responsible for maintaining and changing the visual properties (colour, thickness etc.) of created or selected annotation elements. The visual composition of the browser view-ports and the annotation layer is directly handled by the operating system with an independent transparent child-window.

![MVC Application Design](image)

**Figure 4: MVC Application Design**

The screen recorder is implemented as a stand-alone application bundled with the presentation software. It is controlled via distributed objects – a system for inter-application-communication on Mac OS X. When a connection is established from the main application, the recorder responds to requests like starting, pausing or triggering chapter marks (navigational indices). The grabbing process itself operates via a read-only full-screen OpenGL-context in conjunction with the `glReadPixel`-Function, which copies pixels from the video buffer.

4.3 Evaluation of criteria for lecture recording

To compare the developed system with common requirements and features of other systems, a catalogue of important criteria for lecture recording systems can be used (table 1). Peter Ziewer (Ziewer 2006) extracted and merged various aspects of existing catalogues (Lauer and Ottmann 2002, Mertens and Rolf 2003) to a final catalogue of eleven items. It does not claim to be complete and suitable for all kinds of evaluation, but reveals the most important aspects. The importance of certain criteria can be very different for several usage scenarios – for instance navigational indices are not important for synchronous electronic lectures in distance learning (Ziewer 2006).
Table 1: Criteria for Lecture Recording Systems (Ziewer 2006)

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Subcriteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>C01</td>
<td>Verbal Narration</td>
</tr>
<tr>
<td>C02</td>
<td>Live Video</td>
</tr>
<tr>
<td>C03</td>
<td>a) Format of Presentation Documents</td>
</tr>
<tr>
<td></td>
<td>b) Supported Presentation Software</td>
</tr>
<tr>
<td></td>
<td>c) Supported Additional Applications</td>
</tr>
<tr>
<td>C04</td>
<td>a) Type of Annotations</td>
</tr>
<tr>
<td></td>
<td>b) Dynamic Capture and Replay of Annotations</td>
</tr>
<tr>
<td></td>
<td>c) Annotation Associated with Segments</td>
</tr>
<tr>
<td></td>
<td>d) Student Note-Taking</td>
</tr>
<tr>
<td>C05</td>
<td>Metadata</td>
</tr>
<tr>
<td>C06</td>
<td>a) Video-like Editing</td>
</tr>
<tr>
<td></td>
<td>b) Content Editing</td>
</tr>
<tr>
<td></td>
<td>c) Creation of Distributable Media</td>
</tr>
<tr>
<td>C07</td>
<td>a) Structured Electronic Lectures</td>
</tr>
<tr>
<td></td>
<td>b) Random Access</td>
</tr>
<tr>
<td></td>
<td>c) Visible Scrolling</td>
</tr>
<tr>
<td>C08</td>
<td>a) Searchable Content</td>
</tr>
<tr>
<td></td>
<td>b) Range of Searchability</td>
</tr>
<tr>
<td>C09</td>
<td>a) Lossless Reproduction</td>
</tr>
<tr>
<td></td>
<td>b) Scalability</td>
</tr>
<tr>
<td></td>
<td>c) Streamability</td>
</tr>
<tr>
<td></td>
<td>d) Format</td>
</tr>
<tr>
<td></td>
<td>e) File Size and Bandwidth</td>
</tr>
<tr>
<td>C10</td>
<td>Platform Independency</td>
</tr>
<tr>
<td>C11</td>
<td>Synchronous Electronic Lectures</td>
</tr>
</tbody>
</table>

As already mentioned in section 1, the primary streams are the instructor’s verbal narration (C01) and the visual presentation content (C03), whereas the live video (C02) is not that important, but should be supported. A key aspect of this paper is the flexibility of presentation, which is covered in this catalogue by the subcriteria C03 a) – c). Especially in criterion a), the developed prototype differs a lot from existing systems due to its browser-based scene concept. It not only supports common file formats, but features technologies like Java and other dynamic web content. Even an external presentation software can be used like any other application (C03 b+c), but in this case no metadata can be extracted directly. The design of the virtual overhead’s annotation feature (C04) is another aspect of distinction in comparison to existing systems. It mirrors common slide elements (C04 a+b) in a very dynamic and flexible way enabling the instructor to express in a wider range. Moreover annotations are bound to scenes (C04 c) and even are aligned with scrollable content. Admittedly students’ notes can not be included into the final lecture video. Metadata (C05) for the lecture itself (like Learning Objects Metadata – LOM) are supported only indirectly through video formats or html-pages used for distribution. Post-processing and distribution can be applied as with every video asset (C06 a+c), but due to the hybrid lecture recording approach (pixel-based), the content itself can not be edited (C06 b).

Another key aspect of this paper are navigation and retrieval features, which are covered by criteria C07 and C08. The hybrid lecture recording approach makes it possible to set navigational indices when scenes are switched during the presentation (C07 a), whereas random access and visible scrolling (C07 b+c) are supported through the video formats used for distribution (Apple QuickTime recommended). Although information retrieval and searching (C08) is not yet implemented, the system’s design and the browser-based scene concept allow for comprehensive metadata, like extracting XHTML source code for search indices. As already mentioned, the lecture is distributed via several wide-spread pixel-video formats, which in most cases do not support lossless reproduction or spatial scalability (C09 a+b). The prototype presented in this paper was developed for Apple Mac OS X only in order to reduce development time and access special features, thus is not independent of platform decision (C10). But the overall concept and design can be transferred to a cross-platform base (like Mozilla). Finally, synchronous electronic lectures are planned, but not yet implemented.
5. Conclusion and future work

This paper started with a comparison of basic lecture recording approaches, which lead to the concept of a hybrid system as the most promising starting ground for further development. It allows navigational and search metadata to be gathered directly from the connected presentation software, but even enables flexible presentations by supporting external applications (section 2.4). Because additional programs cannot provide metadata directly and are difficult to integrate seamlessly into the presentation, this paper set up the following thesis: The more flexibility is directly incorporated into the presentation application itself, the easier the presentation is to control for lecturers and the more metadata can be extracted directly (section 2.5).

To accomplish this, a browser engine was proposed as basis for more flexible presentation software. It supports numerous wide-spread interactive formats and standards and is extensible in various ways. Moreover, it offers the possibility to immediately use web content. Together with this a shift of metaphors from “slides” to “scenes” was proposed to reflect the orientation on interactivity. In turn a “scene” metaphor suggested additional modifications like a modeless design (no distinction between authoring and presentation) and a highly dynamic annotation layer. In order to validate the concept of a browser-based scene concept, a prototype called “Virtual Overhead” was developed and will be used for the conference presentation. The prototype was compared to existing systems and common requirements. For this comparison a catalogue of criteria developed by Ziewer (2006) was used.

As not every desirable feature has been implemented yet, search functionality and retrieval have to be developed in near future, starting with extracting metadata from both XHTML-code and textual annotations. A suitable container for this data has to be identified together with the implementation of methods for user-driven search-queries. Furthermore, synchronous distance lectures have to be supported. The frames already grabbed for recording can as well be used for streaming, when properly compressed.

In summary, the proposed browser-based scene concept was identified as a possibility to offer more interactivity and visual expression to lecturers. Finally, this approach seems to be suitable to solve the contradiction between flexibility of presentation and structural or symbolic information.

References

Help! Active Student Learning and Error Remediation in an Online Calculus e-Help Community

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Abstract
Free, open, online homework help sites appear to be extremely popular and exist for many school subjects. Students can anonymously post problems at their convenience and receive responses from forum members. This mode of tutoring may be especially critical for school subjects such as calculus that are intrinsically challenging and have high attrition rates. However, educational research has focused on tutoring sessions that instruct students on a pre-determined set of material or topics, and there has been no systematic research on these dynamic, free, open, online tutoring communities. In order to distinguish the student-initiated e-help episodes from traditional tutoring sessions, we refer to them as “tutorettes.”

Each tutorette was assigned a participation code that contained information on the number of contributions by each participant, the sequence of contributions, and the number of different participants. Student problem solving activity, defined by mathematical contributions and efforts, was measured for initial postings and for subsequent contributions. Finally, each tutorette was examined for evidence of mathematical errors and these were classified according to type: pre-calculus, operational, and conceptual. A tutorette on the limit concept is provided to demonstrate how mathematical queries are resolved in an SOH e-help community.

Participation and problem solving attempts provided evidence of active student learning. Instead of simply using the tutors to do their homework, many students made initial attempts at solutions, queried tutor responses, and applied the help they received to make progress on solving problems. This behaviour appeared to be influenced by the actions of the tutor: Providing solution sketches accompanied by asking direct questions encouraged dialogue, whereas providing quasi-complete worked solutions seemed to have the opposite effect.

In contrast to classroom instruction, students in this e-help community appeared comfortable in presenting incorrect work and tutors were open and forthright in their commentaries, evaluations, and explanations. In addition, tutors modulated their responses according to the type of error. Pre-calculus errors and operational (calculus) errors were not accorded the same depth of explanation as conceptual misunderstandings.

Keywords: tutoring, e-help communities, discussion forums, calculus tutoring

1. Introduction
Help-seeking is recognized as an effective means for students to cope with academic challenges (Nelson-Le Gall, 1985), and student-initiated tutoring, in which a student seeks a tutor for help (usually for a specific problem), is a common manifestation of this phenomenon. This type of tutoring traditionally occurs in face-to-face settings, such as in university-sponsored help centres. However, since computer networking has become ubiquitous, a new context for tutoring has emerged in which students and tutors are not necessarily linked by physical proximity. The “net generation” (Oblinger and Oblinger, 2005) and “digital natives” (Prensky, 2001) are using the Internet to voice their requests for help. Students are participating in topic-specific, free, open, asynchronous Web-based forums for help with homework problems and answers to questions. These e-help communities may be the only recourse some students have for receiving help outside of the classroom on homework assignments or on studying for examinations. In particular, this opportunity is critical for some students taking introductory calculus, a course that is renowned for its challenging nature and high attrition rate. A casual survey of the Internet posting subjects for mathematical discussion forums that include subjects such as geometry, trigonometry, and standardized test preparation reveals that calculus is one of the most frequented subject areas, with multiple postings daily. However, despite the existence and apparent functionality of several mathematical help forums for today’s students, there has been no systematic study of student-initiated tutoring in Web-based forums.

In order to distinguish the tutoring exchanges that we study from the “tutoring” that has been the subject of previous educational research, we use the term “tutorettes” for student-initiated episodes that are typically brief and involve a specific problem situation. In contrast, the “tutoring” that has been the subject of previous educational research resembles scaled-down classroom instruction in that the tutor is assigned the task of covering a pre-determined topic or set of topics (see Cohen, Kulik and Kulik, 1982 for a meta-analysis of 65 studies). In opening up this new area of research, many questions can be posed and answered: What are the effects of different participation structures (van de Sande and Leinhardt, 2007)? What are recurring...
patterns of questions around a given topic? What are the similarities and differences between face-to-face help center encounters and online tutoring in the same content (van de Sande in preparation)? The research reported here examines the extent to which Web-based tutorettes reflect active student learning and error remediation, two elements of effective instruction according to educational research. A tutorette on the mathematical concept of the limit is presented as an example of how a challenging topic is discussed and resolved in a tutoring e-help community.

1.1 Active student learning

In order to learn, an individual must become actively engaged with the material, ideas, and uses of concepts and procedures to be learned. However, there are a variety of ways in which a learner can be active. Most reform-based educators urge a particular kind of active learning, for instance, that instruction should position students as active participants in the construction of knowledge rather than as passive recipients of information (Greeno, 2003; Lave and Wenger, 1991; Rogoff, 1990). This position calls for both a definition of “active” participation and methods of assessment. According to Scardamalia and Bereiter, (1991), active student learners are those that select problems, ask questions, and self-monitor their understanding. Although there is ample evidence to suggest that productive student engagement and participation fosters learning, active student learning is not a feature of typical classroom instruction. One explanation for its absence involves pragmatics: Coordinating a large number of students learning simultaneously might interfere with active student participation on an individual basis. However, active student engagement, as measured by the initiation of exchanges and question-seeking behavior, was also not supported in face-to-face, one-on-one tutoring sessions (Graesser, Person and Magliano, 1995). Although student questions were more frequent in these tutoring contexts than in classroom settings (Graesser and Person, 1994), the majority of questions were asked by tutors and students rarely initiated exchanges.

Active student learning, then, does not appear to be a phenomenon that naturally occurs in face-to-face instructional settings. Are other instructional settings more amenable to active student learning? By definition, online homework help forums are likely locations for active student participation since it is the role of students exclusively in these forums to initiate questions and seek resolution. In addition, the asynchronous and anonymous nature of such exchanges would seem to encourage student participation. Students are not constrained by the pace of instruction, can pose questions as they arise, and are able to present ideas in an environment where face-saving is not an issue. However, there is the possibility that students participating in web-based tutorettes are “executive” (or dependency-oriented) versus “instrumental” (or mastery-oriented) help-seekers (Nelson-Le Gall, 1981). That is, these students may appear to be active learners but may simply be seeking worked solutions to homework problems rather than seeking help on understanding the relevant procedure or underlying concept. In our corpus of online calculus exchanges, we distinguish between these types of help-seeking by looking for evidence of active student learning in terms of student participation within tutorettes and in terms of student problem-solving contributions.

1.2 Errors and error remediation

Errors are mistakes: Some errors are trivial and some represent a quite profound misunderstanding of the situation. When students produce errors in the process of engaging with mathematics, it can be a moment of learning if the error sets up an occasion of serious exchange and consideration of the ideas involved in making the mistake. Therefore, it is precisely in these situations that the response of a tutor is critical. Following an error, a tutor may provide information about the existence, the nature, or the consequences of the error, and may do so in an explicit manner or less directly by hinting. Analyzing the timing and informational content of feedback (McKendree, 1990), the manner in which it is presented (Lepper et al, 1990), and the underlying situational features that prompt different tutor responses (Hume et al, 1996), has been instrumental in understanding the effectiveness of (human) tutoring and in shaping the design of computer-based tutoring systems (Merrill et al, 1992). One key finding is that tutors appear to modulate their responses based on the perceived criticality of an error: Errors that are judged to be less consequential for learning are treated in a different manner than errors that are considered to involve focal goals or objects in the domain (Littman, Pinto and Solway, 1990; Merrill, Reiser and Landes, 1992).

Do tutors modulate their responses to student errors in online e-help communities? Although they are instructional by nature, tutorettes are quite different from the traditional tutor sessions that have been used for the evaluation of feedback. For instance, the tutors are not constructing “tutoring plans” that will support extended instruction with the student. Instead, their goal is to quickly and efficiently answer a given student query before moving on to the next. At the same time, the tutors in e-help communities are in a position to
make some assessment of a student’s knowledge state by the work that is posted, the way a question is framed, and the response to their actions. As a first step for investigating errors and error remediation in calculus tutorettes, we have constructed a system for classifying the mathematical errors in our corpus and have explored the corresponding patterns of remediation.

2. Methods

2.1 The corpus

As part of our ongoing research, we have collected and analyzed tutorettes from free, open, online help sites that represent different participation structures, span international borders, and pertain to various mathematical topics. We have identified two basic participation structures: Spontaneous Online Help (SOH) sites permit any forum member to respond to postings, whereas Assigned Online Help (AOH) sites assign postings to vetted volunteer tutors. The corpus used in this study (Cohort 1) contained 100 sequential introductory calculus SOH tutorettes that were collected from www.mathgoodies.com. MathGoodies.com is representative of other math homework SOH sites and includes an active pre-calculus and calculus homework help forum. The Advanced Placement Calculus course description (College Entrance Examination Board, 2003) was used to delineate “introductory” (versus pre-calculus or advanced) calculus tutorettes that were included in the analysis. The Math Goodies homework help forums are part of an online resource founded in 1998 and maintained by former secondary mathematics and computer science instructor, Gisele Glosser. Although this is an SOH site, there are assigned moderators for each individual forum who can edit, delete, or prune posts. Other participants are categorized as New Members, Average Members, Senior Members, or Advanced Members depending on their number of postings, either giving or seeking help. The explicit rules for participation in the forum include a mandate not to request help on take-home exam questions, a request to search the forum prior to posting a question, and admonitions to specify the entire question (including instructions), to show one’s work on the problem, and to use the provided mathematical symbol keys to facilitate communication.

2.2 Coding

Problem-solving activity was measured by student participation within a given tutorette and by contributions to the problem-solving activity. Each posting was assigned a “participation code” that differentiated the participants of that posting and characterized the sequence of activity. A “1” was used for the initiator of the posting, “2” was used for the next participant, and so on. For example, a participation code of 1231 would be a posting by three forum members in which a student (1) requested help, participants (2) and (3) responded, followed by a final contribution from the student (1). The length of a code, then, signifies the number of exchanges in the tutorette, the ordering of numbers within a code tracks the sequence of participation, and the largest number in the code reflects the number of different participants in the exchange. In addition, each tutorette was examined to see if the student demonstrated problem-solving activity in the initial posting and whether there was subsequent activity as the tutorette was enacted. There were four possible classifications, representing all possible initial/subsequent problem-solving activity configurations. In order to distinguish between executive and instrumental help-seeking, the classification was conservative; thus, to qualify as a problem-solving attempt, the effort had to extend beyond listing possible strategies or questioning a tutor to include an explicit proposal of solution steps. Two coders independently classified problem-solving activity with high inter-rater reliability ($\kappa = .93$, $n=20$), and all disagreement was resolved through discussion.

In order to investigate errors and error remediation, the content of each of tutorette was coded for mathematical accuracy. Errors were defined as statements that were logically inconsistent or demonstrated a misunderstanding regarding some aspect of mathematics as opposed to those that indicated a lack of knowledge. The errors were then classified according to type: pre-calculus, operational, and conceptual. Pre-calculus errors involved arithmetic miscalculations (such as incorrect summands) or violations of algebraic principles (such as the distributive law). Operational errors involved the incorrect implementation of an algorithm or procedure of calculus (such as the chain rule). Conceptual errors, as the name suggests, involved the misunderstanding of a calculus concept (such as the limit). A posting could contain errors of more than one type, and each error was classified separately.
3. Results

3.1 Active student learning

In order to detect active student learning, we first examined the participant codes (Figure 1) for the presence of student participation beyond initiating the posting. One broad indication of student activity is the likelihood of a student re-entering a discussion; active learners would be more likely to make contributions and to extend exchanges. Although for many of the tutorettes there is no record of whether or not the student profited from the help or engaged in any further activity on the particular problem, the student who initiated the dialogue made at least one further contribution in 46 instances and made two or more additional contributions in 17 instances. These numbers indicate that many students are engaging in discussions in this e-community. However, this analysis, on its own, does not reveal the nature of their contributions and whether the participation is indicative of executive or instrumental help-seeking.

Figure 1: Percentages of participant codes. “Other” category includes two unanswered postings and other less common participant codes. A closer examination of initial and subsequent problem-solving efforts by the student-initiators provides a more refined measure of student activity and helps discern between executive and instrumental help-seeking. Figure 2 shows the percentage of tutorettes that display initial and subsequent attempts by the student-initiator at solving the problem.
Figure 2: Student-initiator problem-solving activity.

Twelve percent of the tutorettes reflect problem-solving activity both initially and subsequently, 14% reflect an increase in problem-solving activity, 29% reflect problem-solving activity by the student in the initial posting only, and 44% reflect no problem-solving activity by the student-initiator. These latter categories are potential indicators of web-based SOH sites enabling executive help-seeking and were examined more closely to determine tutor actions that may have contributed to the lack of student problem-solving activity. If, for example, tutors provide complete worked solutions, then there is less incentive for students to engage in problem solving.

The tutorettes in which the student-initiator did not participate in any problem-solving activity beyond perhaps an initial attempt revealed several characteristics of tutor activity that may contribute to a low level of student problem-solving activity. In the majority of these tutorettes, the student received a complete worked solution \((n=23\) for no initial student attempt, \(n=10\) for initial student attempt) or a partial solution or solution outline \((n=13\) for no initial student attempt, \(n=10\) for initial student attempt). The level of detail in the solution sketches varied greatly, but there were several instances in which the challenging part of the problem was provided for the student with only a few remaining algebraic steps left for the student to complete. In some cases, one tutor responded to a student with a solution sketch, and, without any further contributions from the student, another tutor volunteered a full worked solution, potentially deterring the student from attempting to apply the sketched solution steps. Thus, the “spontaneous” characteristic of this web-based forum, although potentially a mechanism for catching mistakes and introducing multiple perspectives, is sometimes redolent of “too many cooks in the kitchen.”

Alternatively, the examination of tutor actions in tutorettes that resulted in an increase in student activity may reveal ways of supporting and encouraging student problem-solving attempts. Although the number of such tutorettes was small in this corpus, some tutorial moves did appear to support instrumental help-seeking. For example, the inclusion of partial solutions or solution sketches followed by a direct question, such as “What do you need to integrate to find the arc-length?”, provided limited information and directly prompted students to work further on the problem. Hinting, in this fashion, is a common tactic used in traditional tutoring sessions that functions as a prompt for students to access information already known and to carry out the next solution step (Hume et al, 1993).

3.2 Errors and error remediation

Because previous research has shown that tutors, as well as students, make mathematical errors in Web-based and face-to-face tutorettes (van de Sande and Leinhardt, 2007; van de Sande, in preparation), we examined the contributions of participants in both roles. The error rate for tutor contributions was impressively low for this corpus. Only three tutorettes contained mathematical errors made by tutors. Two of these were sign errors (one involving the computation of a derivative and the other the factorization of a quadratic) and the third concerned a trigonometric identity. In contrast to other SOH corpora that we have analyzed, none of these errors was discovered or addressed by another forum participant. In general, SOH communities are wikipedia-like and members share responsibility with one another by catching mistakes and publishing corrections. However, the fact that two of these tutor errors were relatively minor may have contributed to their slipping by unnoticed by others. One sign error result was a value to be squared so that its sign was, in some sense, irrelevant; the other sign error occurred in an explanation of a removable discontinuity and did not affect the ultimate conclusion. The remaining error occurred when a tutor utilized a trigonometric identity that is not generally well known and, therefore, may not have been detected by fellow participants.

In contrast, the error rate for student contributions was relatively high. Of the 55 tutorettes in which the student displayed problem-solving activity, 34 contained errors. This finding attests to the function of open, online, help forums as safe environments for students to present their work and tutors to critique this work, as well as to the social norms of this particular e-help community. Students did not appear to be concerned with “saving face” and tutors did not appear to be constrained by universal conversational maxims and politeness principles that, in face-to-face encounters, may conflict with pedagogical goals (Person et al., 1995). Also, the “rules for participation” for the mathgoodies.com community specified that students were

---

1 One posting was a request for a reference and was therefore excluded from this analysis.
2 The “spontaneous” characteristic of this help site is reflected by the number of tutorettes (39) in the corpus in which more than one tutor participated, either addressing the student or another tutor.
responsible for showing all work, and students who routinely did not show work were sometimes chastised and denied help. This practice encourages students to publish their misunderstandings and incorrect results, thereby contributing to the magnitude of the error rate.

**Table 1:** Type and number of student errors with example of each.

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-calculus</td>
<td>8</td>
<td>-sin t – (sint t + t cos t) = -2sin t + tcos t</td>
</tr>
<tr>
<td>Operational</td>
<td>15</td>
<td>Use of the harmonic series, 1/n, to investigate the convergence of the series n/(n+1)^2(n-1)</td>
</tr>
<tr>
<td>Conceptual</td>
<td>14</td>
<td>f(x) = x^6 – 3e^x cos(x) + e^3.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>f'(x) = 6x^5 -3xe^(x-1)cosx + 3e^xsinx + 3.5e^2.5</td>
</tr>
</tbody>
</table>

Table 1 shows the number of student errors in this corpus according to type and an example of each. The majority of the errors that students made were calculus-based, either involving the implementation of an algorithm (15) or the misunderstanding of a concept (14). Only 8 errors pertained to arithmetic or algebraic operations. Of these, 2 were arithmetic errors, 4 were errors concerning the distributive property, and 2 resulted from incorrect calculations of a function value. The typical response of the tutors to this type of error was to draw attention to the mistake (directly or using hints), with minimal explanation of the violated principle. For instance, when a student was performing differentiation and, in the process, neglected to distribute the negative sign to both terms of an expression, a tutor responded by pointing to the line that contained the error and identifying the incorrect term in the expression using red-colored font: “–sint – (sint + tcost) = -2sin t + tcos t < -- here is your mistake ... check the sign of tcost.”

Despite the difference in the mathematical domain (calculus vs. pre-calculus), the errors that students made in operationalizing a concept met with much the same response: The error was corrected with little explanation of the underlying principle. For example, when a student was investigating the convergence of an infinite series using the limit comparison test and chose an unproductive comparison series, a tutor responded by providing an appropriate comparison series and solution but with no explanation regarding the student’s failed attempt. This mode of response to operational errors in tutorettes is in keeping with research on traditional tutoring in that tutors generally do not perform detailed evaluations of students’ knowledge (Putnam, 1987) or make inferences about specific student “bugs” (McArthur, Stasz and Zmuidzinas, 1990). Presumably, the errors that we classified as operational matched with those that the tutors judged to be less consequential for learning and were therefore treated somewhat cursorily.

The third type of error centred on conceptual misunderstandings or interpretations. Tutors responded to this type of error in a very different way from the way they responded to the other two error types and they generally provided explanations that invoked mathematical definitions and principles. For example, when a student overgeneralised the rule for differentiating powers to exponential functions, the tutoring included responses such as: “The derivative of an exponential term is the exponential term times the derivative of the exponent” and “Remember, the derivative of a constant is 0, therefore, e\(^{3.5}dx\) is 0.” Responses of this nature prompted students to reformulate their understanding of the concept. In this example, the student queried, “Oh, the derivative of -3e\(^x\) is itself?” and a tutor replied with a proof of this fact using the product rule on the terms -3 and e\(^x\).

We hypothesize that many errors of this latter type may result from an unproductive perspective on the problem situation, specifically one that does not afford reasonable opportunities for solution (see Greeno and van de Sande, 2007 for a discussion of perspectival theory). Adopting a visual analogy, problem solvers reach an impasse when there are some (mathematical) objects that are not placed in the foreground or background in a helpful manner. In some cases, an unproductive perspective may be the result of trying to operate according to a schema that is too specific and therefore not applicable. This difficulty results from the tendency of students to latch onto simple examples that a mathematics instructor uses to introduce a new topic. Students then construct a schema for solving problems that is limited to these example types: “[It is] almost impossible to give students simple experiences without giving them correspondingly simple long-term conceptions of the concepts being introduced” (Davis and Vinner, 1986). Constructing an alternative perspectival understanding is an effortful process, but one that has implications for conceptual growth (Greeno and van de Sande, 2007). In the next section, we present an example of a tutorette that illustrates how an alternative perspective was introduced and adopted by a student.
4. A tutorette on the limit

The following example illustrates how an SOH site can function as a collaborative tutoring effort to effectively help students understand a challenging calculus concept, namely the limit. The exchange is an example of instrumental help-seeking in which two tutors (pka and tkhunny) responded with alternative perspectives. The student (density) questioned the first tutor's solution. Because the first tutor was unsuccessful at framing an explanation for the student, s/he requested an additional tutoring help. Another tutor entered the dialogue and provides the sketch of a solution from an alternative perspective. (The participant code for this dialogue between the student and the two tutors is 1212131.) This second perspective was successfully understood by the student, and the situation was resolved.

The formal mathematical definition of the limit, in particular, is often a source of extreme difficulty for students (Tall, 1993), although its presentation, at least to some extent, is not unusual in an introductory calculus course. Typical problems include the application of the formal definition of the limit to a given function. Instruction usually begins with linear functions and then progresses to more complex cases, such as reciprocals (e.g., f(x) = 1/x). The application of the formal definition to a linear function can be performed using a sequence of algebraic manipulations (factoring followed by division) but this ‘procedure’ does not extend to more complex functions without significant modifications. This situation presents a difficulty for students who have acquired a schema for applying the formal definition but have not grasped the underlying limit concept.

In the initial posting, density posed the problem and an attempt (albeit weak) at starting a solution. As is often the case with homework assignment from a textbook, density knew the final answer but could not construct the accompanying solution steps:

A short time later, a tutor (pka) responded with a partial solution, preceded by a comment on the nature of such problems for introductory calculus:

Despite the characterization (“I normally would not give such a complete solution.”), pka did not provide a complete worked solution but rather provided select solution steps and ended the posting with a question, “Can you see that delta = 2/3?” This move encouraged active learning since density was prompted to use this additional information to work through the problem. Density responded by questioning how pka's
solution supported the answer and presented his/her work on the problem. This work corresponded to the enactment of a schema for applying the formal definition of the limit to a linear function and resulted in an acknowledged impasse. **Density** was trying to manipulate the absolute value expression to resemble the desired algebraic form which would have $|x-4|$ on one side of the inequality and a constant multiple of $\epsilon$ on the other:

$$
\begin{align*}
&\left|\frac{5}{4}/\left(\frac{1}{4}\right)\right| = \left|\frac{x(x)}{\left(\frac{1}{4}\right)}\right| < \epsilon \\
&\left|\frac{5}{4}/\left(\frac{4}{x}\right)\right| = \left|\frac{x}{\left(4x\right)}\right| < \epsilon \\
&\left|\frac{5}{4}/\left(\frac{4}{x}\right)\right| = \left|\frac{x}{\left(4x\right)}\right| < \epsilon \\
\end{align*}
$$

and then I'm left with $1/4|x-4| < \epsilon$

but now how do I isolate that $|x-4|$ so that I can find epsilon?

**Pka**, however, was apparently unable to explain the solution and called for help from other forum participants. This is evidence that, just as students seem comfortable voicing questions and producing imperfect work in this e-help community, tutors also appear comfortable publicly acknowledging difficulties:

**Density** responded apologetically and clarified his/her state of understanding. **Density** understood how **pka** could arrive at the final answer if an earlier claim was accepted (**pka**: “Note that I solved the inequality”) but did not understand the justification for this claim, especially in light of the impasse that **density** had reached:

It is at this point that another tutor, **tkhunny**, entered the dialogue and presented an alternative perspective that focused on the dynamic nature of limits; the value of the limit of a function at a point (if it exists) is the value that the function is arbitrarily close to as the independent variable approaches that point. Thus, **tkhunny** suggested considering the behavior of the function for values LESS than 4 and values GREATER than 4. The absolute value – the source of **density**'s impasse – was then equivalent to a simple inequality for each case:

Although **tkhunny** did not provide a complete worked solution (leaving the solution of the inequalities to **density**), this sketch was sufficient for **density** to adopt the alternative perspective and thereby to understand the derivation of the interval in question. **Density** replied with gratitude and enthusiasm, demonstrating clearly the effectiveness of the help received:
Despite the apparent success of this tutorette, however, its outcome is not without concern. Although density was able to solve the problem by adopting the perspective of tkhunny, there is no indication that density made progress toward reconciling the original schema-based approach and this alternative perspective. In other words, it is most probable that, following the exchange, density retained two disconnected perspectives on the formal definition of the limit: a schema-based approach for linear functions and a dynamic approach for more complex functions, such as reciprocals. The relationship between these two was not constructed in the tutorette. This example calls attention to the importance of carefully examining the ways in which tutors specifically address and build upon student activity, especially in light of constructing an understanding of the student's perspective. Instruction as a collaborative activity requires that tutors take student perspectives into account rather than simply presenting alternatives.

5. In Conclusion

Students are turning to discussion forums in order to receive help on mathematics homework assignments and studying for examinations. These sites are a resource that allows students to complete homework assignments and learn outside of classroom instruction and may be critical for the success of some students, especially in introductory calculus courses. Because participants are anonymous, these communities provide a relatively safe environment for asking questions, presenting solutions, and critiquing work. In addition, several of these homework help forums have the added benefit of being free of cost. While some of these forums provide tutoring from assigned volunteer tutors (usually mathematicians or upper-level mathematics students) who meet certain criteria (AOH sites), there are also several forums that provide spontaneous help by other members of the e-community (SOH sites). The research reported here investigated a corpus of 100 sequential tutorettes on introductory calculus topics from one such SOH site that is taken as representative of other web-based homework help forums of this type. The analyses focused on active student learning and error remediation, two elements of effective instruction.

Active student learning involves problem selection, questioning, and self-regulation and is a desirable element of instruction that is not often achieved in traditional classroom situations or in traditional face-to-face tutoring (Graesser, Person and Magliano, 1995). However, there was evidence of active student learning in the SOH tutorettes. If students in this community were solely “executive” or dependency-oriented help-seekers, then the participation codes would have been limited to instances of “12”, that is, postings in which a tutor responds to a student query. This was not the case. Instead of simply using the tutors to do their homework for them, many students took part in these dialogues as “instrumental” or mastery-oriented help-seekers; students made initial attempts at solutions, queried tutor responses, and applied the help they received from tutors to make progress on solving problems. Furthermore, this behavior was influenced, at least to some extent, by the actions of the tutor. Some tutor actions seemed to encourage active student problem-solving, whereas others may have discouraged it. In particular, providing solution sketches (versus complete worked solutions) accompanied by asking direct questions encouraged dialogue; providing complete (or close to complete) worked solutions seemed to have the opposite effect.

Related to the issue of active student learning in instruction is the issue of how errors are handled. One mark of a learning community is that ideas can be questioned, elaborated, challenged, and revised safely. In practice, this has proven problematic for face-to-face instructional settings, where students tend to refrain from asking questions and presenting work that displays knowledge deficiencies and tutors are sometimes reluctant to criticize student contributions. In the SOH e-help community, however, students appeared comfortable in presenting incorrect work and tutors were open and forthright in their commentaries, evaluations, and explanations and vice-versa (van de Sande, in preparation). Saving face was clearly not the central concern, although members still adhered to a standard of politeness: Criticism was directed at the incorrect mathematical information rather than at contributors. In addition, e-help tutors in the SOH community modulated their responses according to the type of error. Pre-calculus errors and operational (calculus) errors were not accorded the same depth of explanation as conceptual misunderstandings.
The e-help community that we chose for this project was characterized as spontaneous online help. That is, any forum member could take on the role of tutor, regardless of mathematical expertise or instructional experience. This participation structure fostered collaboration between individuals with different abilities, specialties, and interests. In this corpus, the collaborative potential of an SOH site was evident in the participation by multiple tutors per posting; as many as 4 different tutors took part in a single tutorette. The spontaneous (SOH) feature of the discussion forum also encouraged and supported the contribution of alternative perspectives on problems. We concluded that this “party-line” characteristic of SOH sites has the potential of helping both students and tutors understand problems in a multitude of ways (many of which may be novel). However, as the tutorette on the formal definition of the limit demonstrates, the benefits may be curtailed if tutors do not connect their responses to a student’s perspective and help reconcile alternatives.

The larger aim of this project aims to define and evaluate effective learning in the context of Web-based tutorettes. As a starting point, we have begun investigating features of ideal instruction that stem from cognitive research and that have been applied to traditional face-to-face tutoring corpora. Clearly, this is not an ideal fit since the goals, setting, and composition of the instruction are vastly different. On the other hand, at the core, tutorettes are instances of instruction and learning, and, as such, share many of the same ideals. Understanding how these ideals (and potentially others) are realized in e-help communities is important for a number of reasons. First of all, these communities are flourishing as instructional support for today’s students. Given that these communities may become the new norm for seeking help on homework, it is important to understand how they function and how they impact students’ understanding. Do tutorettes help students beyond the construction of a solution for the problem that is posted? A second reason for pursuing this research involves the variety of forum types available -- gratis versus subscription and AOH versus SOH. Do these communities manifest different elements of ideal instruction, and, if so, which ones and why? For instance, it may be the case that SOH sites are more likely to introduce students to multiple perspectives on a given problem, whereas AOH sites tend to encourage more in-depth explanations. Knowing how the different e-based communities function could inform the formation or endorsement of such a community. Finally, this research has implications for the design of intelligent tutoring systems, particularly those that contain a dialogue component such as an automated pedagogical agent. These systems reside in computer environments and, as such, have much in common with Web-based homework help sites. Identifying the ways tutors communicate with students in e-communities can inform the construction of more realistic and effective computerized pedagogical agents. In general, the message is clear: Students of today are voicing their appeals for help in web-based homework help forums. As educational researchers, what, then, is our response?

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References


Seven Years of Linking Scottish Schools and Industry with SSTN

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Abstract: The Scottish Science and Technology Network (SSTN) is a major collaboration between Careers Scotland and Scottish industry to promote science and technology via an on-line and integrated learning programme. An initial two-year pilot project has grown considerably and has now been running for over 7 years. The SSTN programme is a web-based application that supports teachers with automatic identification of learning resources, course planning tools, classroom-based delivery (within the 5-14 curriculum) and mentoring support. This paper presents a summary of this project and examples of typical usage scenarios. We present our project findings from this 7 year programme and details of our further development plans. Findings presented include lessons learnt, our best practice guidelines, effective user interface design for learning, integration learning resources and strategies for hiding complexity.

Keywords: Scottish, science, technology, Careers Scotland, SSTN.

1. Background

1.1 Decline in science and technology as a career path

Within Scotland the falling number of pupils that are adopting science and technology as a career path has become a significant political and social concern. Over the past few years there has been an on-going decline in the number of pupils taking both science and technology based subjects at school and then later choosing to study these areas in higher education. This decline has been particularly pronounced for girls studying these subjects.

The future economic implications of this decline for Scotland has led the Scottish Executive to make the promotion of science – and in particular technology – a key underpinning objective of their educational activity programmes. As the principle agency in Scotland providing career education, information and guidance – Careers Scotland – was directed to address this decline. As part of this remit this project has been developed in partnership with Scottish industry.

1.2 Aim and objectives of this project

The aim of this project is to promote the awareness of science and technology and promote these areas as attractive career paths for young people. Additionally, the objectives of this programme are to:

- Promote science and technology in schools
- Increase adoption of science and technology as a career path
- Enhance the awareness of science issues in young adults (such as global warming)
- Encourage more women to take science and technology as a career path
- Promote the active participation of Scottish industry in the classroom
- Facilitate the use of Information Technology (IT) in lesson planning and delivery
- Directly support the national 5-14 curriculum
- Encourage industrial participation in schools
- Integrate with other on-going educational programmes
- Establish an industry based network of mentors, able to provide assistance to pupils and teachers within Scottish schools on issues relating to science and technology

2. Scottish science and technology network

2.1 Overview

The Scottish Science and Technology Network (SSTN) is a major collaboration between Careers Scotland (Careers Scotland 2007) and Scottish industry to promote science and technology via an on-line system. An
initial two-year pilot project (Stevenson 2003) based in the North East region of Scotland has grown considerably and has now been running at a national level for over 7 years.

The SSTN project links a network of participating schools within Scotland and spans the full spectrum of the 5-14 curriculum. This programme uses a web-based application for supporting learners (aged 5-14), teachers, mentors and administrators and includes an extensive library of Reusable Learning Objects (RLO) – so-called “resources” within SSTN – which has either been specifically developed for this project to address “gaps” in the curriculum or are integrated from external third parties.

The SSTN programme supports teachers with automatic identification of learning resources, course planning tools, classroom-based delivery (within the 5-14 curriculum) and mentoring support. The framework provides a unique resource allocation strategy to deliver content dynamically within the classroom environment and closely integrates with other Careers Scotland programmes such as “Blast Off to Science” (part of the Scottish Space School which is delivered in coordination with NASA) as well as other third party resources.

Additionally, SSTN has previously established an industry-based network of mentors, able to provide assistance to pupils and teachers within Scottish schools on issues relating to science and technology.

2.2 Current project status
As of October 2007 there are 7 major local authority regions in Scotland participating in SSTN and these are spanning the full spectrum of the 5-14 curriculum. The core service is funded by Careers Scotland with regional government contributing to their own local activities and the overall cost of delivering the programme.

Each region of the seven regions has an ‘administrator’ to oversee the on-line and off-line delivery of the programme within their area and a central team (based at Careers Scotland in Glasgow) has the remit of overall direction and delivery. There is an on-going programme of teacher training and development around SSTN and its resources within each region.

This programme has been used as a gateway for other Careers Scotland project and programmes such as “Space Explorers Scotland” and “Blastoff to Science” – see below. This approach has lead to an increased awareness of each programme of work.

3. System architecture

3.1 Overview
The SSTN is a web-based system whose core process allows teachers to outline a profile of a lesson plan they wish to deliver. The teachers’ requirements are expressed using the national (standardised) 5-14 framework (used within Scotland) and are aligned to the individual pupils learning needs. Once the requirements have been expressed – using a simple-to-use wizard based system – the SSTN system then automatically identifies a collection of educational resources (so-called “Reusable Learning Objects – RLO) that fulfil the specified profile.

The identified learning objects can then be delivered on-line to the pupils either individually or in groups with minimal supervision. The teacher has the option to filter (add, remove or change) any of the automatically identified resources to meet their individual teaching needs.

Based around this core process a number of additional processes have been built to add value to the teachers, pupils and other SSTN users. These include:

- **Industry-based Mentor Interactions.** The system has the capability for classroom based pupils to “ask a question” of an industry based mentor (in a secure managed manner). The mentor is notified of this question by e-mail and they can then answer on-line. The record of such dialogues is kept within SSTN and in turn becomes a resource that can be referenced and searched in the future by other teachers and mentors.

- **Lesson Planning Tools.** Using the lesson planning tools teachers can quickly and easily create their lesson plans on-line and then download them for use in either Microsoft Word or Adobe Acrobat formats. By downloading such documents in an editable format teachers can customised them off-line for their own individual needs.
Administration Support. Within SSTN there is the capability to allow regional educational managers to view (via the web) activities within each classroom. This allows the to quickly access in real-time the current situation within each school in their region.

On-Line Forums. These are managed and monitored discussion areas where different communities can hold discussion areas (teachers, mentors, administrators, etc.) This has been used previously to build community based upon geographical location, special events and common areas of interest.

A key objective in the system design was that this process should be quick and easy to use for both the teachers and the pupils alike. In the following sections we outline the key features of the system and then describe the typical usage scenarios.

3.2 Key features

There are a number of novel and key features that have been developed and deployed within the SSTN programme. These include:

- **Architectural Design.** This application’s architecture ensures that it can be readily scaled (capable of being run simultaneously on multiple servers – to provide load balancing and redundancy) and being written in the Java™ programming language it is portable between multiple and mixed environments.

- **Knowledge Representation.** The pilot programme (Stevenson 2003) had previously identified that a novel architecture and representation would be required to meet both the short and the long-term needs of the project. The knowledge representation architecture selected uses a semantic network representation (Quillian 1966) similar in style to Resource Description Framework (RDF) (RDF 2003). This provides a flexible representation, interoperability with other semantic web initiatives and integration with other related areas (such as e-learning standards). However, wherever possible, the complexity of the presentation technology is hidden from the users via a simple-to-use interface.

- **Resources Allocation Strategy.** As described elsewhere (Whittington 2003) the resource allocation strategy provides SSTN with the capability to dynamically encompass and utilize new learning resources – quickly and simply.

- **Strict Alignment with National Curriculum Guidelines.** The project was designed ‘ground-up’ to comply with the latest national curriculum guidelines and therefore meeting national targets. By being capable of supporting multiple standardized curriculum frameworks the system can be regionalized and is capable of handling future changes to the curriculum.

- **Ease of Access and Use.** The deployment of this application is simple and low cost as it can be readily accessed from any standard compliant web browser. The user interface has a simple “flat” layout and uses both wizards and “forms” to provide users with a structured framework for accessing, creating, editing and managing information and workflows.

- **Use of Industrial Mentors.** The way mentors have been deployed in an asynchronous manner in this project has proved to be effective and powerful in supporting continuous project-based activities. This has enabled the latest techniques used in industry to be brought into the classroom and has added significantly to the value of project work. This approach seeks engage pupils with realistic practical industrial situations and applications rather using the “classic” academic study approach alone.

- **Security and Privacy.** A considerable effort has been made within SSTN to ensure that the necessary checks and balances are in place to allow an effective level of security and privacy to be maintained.

- **Real-World Application.** The SSTN is a real-world application and is being actively used and developed with real mentors, teachers and schools.

- **Distributed Web-based Management.** The application is entirely web-based with access to all aspects of its management (from the administrators downwards) being done via a web-based interface.

- **Learning Resource Library.** An extensive library of resources (ROL) has been collected which is directly mapped to the (Scottish) 5-14 curriculum.
3.3 User Interface

Each user role in the system (teacher, mentor, pupil, etc.) has a unique visual design and layout of the functionality based upon a familiar “portal” style (which was far less common when the project was initially started). The user interface has been specifically designed to meet the evolving expectations of a user community. The interface has evolved through several different visual designs as new functionality was integrated during the course of the project. For example, Figure 2 - Tabbed Screen of 'Mentor' Desktop illustrates the layout before additions to the functionality and the corporate re-banding of Careers Scotland and Figure 2 - Tabbed Screen of 'Mentor' Desktop after these changes (not the new tabbed interface to accommodate additional functionality whilst retaining the simple “see everything” ‘direct layout’ approach).

Within this interface we have chosen to use ‘direct layout’ (where all the options and/or fields are displayed on-screen) or ‘wizard-based’ approach. We selected this approach based upon the objective that the users should be able see all the options available to them without having to interact with visual elements (such as menus) to see what options were available. This approach prevents the users from needing to “click to see what is available” and forgetting the location of different options. This approach both reduces training time and makes the user interface appear “simpler” to users whilst still offering them the same level of functionality.

An example of a pupil screen is shown in Figure 3 - Sample Pupil Desktop. The teacher can optional select one of a number of themes to style the pupils’ screen to ensure that it is suitable and engaging for the age range of the pupils.

Help and support for users was also supplemented by the use of ‘screencasts’ that illustrated common tasks that users commonly performed (this also provides a valuable resource for ‘bootstrapping’ administrators and support staff).

More recently (Summer 2007) SSTN software has been updated to incorporate the latest web standards and to increase in compatibility with new mobile devices such as Apple’s iTouch and iPhone unit, which will become available in the UK during the last quarter of 2007.

Figure 1: Classic screen image of ‘Mentor’ desktop
4. Usage scenarios

There are a number of different types of users who participate in the SSTN programme. Some of the SSTN roles include:

- **Teachers** – These are classroom-based teachers who use SSTN to plan and create on-line programmes of work and then later – during classroom time – use SSTN to deliver customised content to their classes.

- **Mentors** – These are industrial based users who provide on-line support for specific topic areas and can interact with classroom-based pupils via the SSTN web site.
- **Pupils** – These are children or young adults who are classroom (or home) based learners and who login to access specific content and resources to meet their learning objectives.

The following sections provide brief scenario descriptions of how the SSTN is being used. The participants in this example scenario are (a) a classroom-based teacher within a secondary school (ages 12-14 years old) (b) pupils (“learners”) studying under this teacher and (c) an industrial mentor (based in an external company).

### 4.1 Teacher lesson planning scenario

Typically each teacher would receive an induction programme delivered as group by their regional administrator. This starts the progress of building a community around the SSTN as the teachers can meet other teachers in their region using the tool and their regional administrator, which makes subsequent on-line communications with individuals easier and more effective.

Once the teacher returns to the classroom, after receiving their initial training, they identify suitable groups of pupils to work with. The teacher would login with their personal account details and enter the profile of the lesson that they would wish to create, using the on-line tools, and the system would identify suitable learning resources and activities for each of the learners or learners groups (where the learners work together and are at the same level of attainment). The teacher would then create accounts for these individuals or groups and then these accounts are immediately enabled for use within the classroom. Each account implicitly has an associated “project” which is the focus of study – for example, “Solids, Liquids and Gases” or “Energy and Forces” are projects that have been undertaken. These projects are automatically linked to the local education authority's programme of work and to the national 5-14 curriculum standards.

For example, in Figure 4 – A Sample Teacher Project Screen is shown that illustrates both summary of the group structure (full hierarchical information can also be displayed if required by the viewer), the groups associated with the group and the resources (both “standard” ones – suggested by SSTN – and the ones added in a customized why by the teacher). Notice the extensive use of automatically hypertext linking of all the elements of the system, which is key to making the system easy to use.

![Figure 4: A sample teacher project screen](image)

### 4.2 Individual and group learner (pupil) scenarios

In the classroom the learners use their individual or group accounts to access the SSTN service via a standard web browser. When they enter the SSTN each of the learners is provided with a unique combination of learning resources, which have been established by the teacher (see previous section). These resources will range from highly specific learning resources (matching as closely as possible the learning needs of the learner at their current level of attainment) to more general resources relating to the
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project being studied. Learners are free to explore these resources or may be guided by their teacher depending upon the learning objectives. Additionally, under the supervision of teachers, learners can initiate either “Question and Answer” or “free form” dialogues with industry mentors who have been assigned to their project.

4.3 Mentoring scenario

The industrial mentors can be automatically or manually identified (“matched”) against each of the project types. Once the match has been made the learners (or the teacher) may engage their mentor by sending a message or a question about the project specifically or about a general (related) topic. The SSTN system does not facilitate direct contact (such as e-mail or chat between learners and mentors) but mediates the conversation for reasons of security, privacy and confidentiality. Any “Question and Answer” dialogues between the mentors can then be used to supplement the Frequently Asked Questions (FAQ) or provide a record for future reference and use by other (non-pupil) users. Mentors are provided with training and promote investigative training. The subsequent school visits by Mentors (where possible) have also been very popular with teachers and pupils alike.

5. Integration with external learning resources

5.1 Overview

During the course of this project a library of specifically authored resources have been commissioned to address specific parts of the supported curriculum where suitable existing resources could not be found. Additionally, sponsors have donated other resources, such as BP’s ETAP resource to our library.

However, a significant number of resources have been located on the Internet and been added to our resource library. We classified these resources into three categories, namely,

- **Tightly Coupled Content.** This type of resource was specifically designed to work with SSTN alone and it was tightly associated with SSTN and could leverage its infrastructure. Full meta-data about the resource is available to use by SSTN.

- **Loosely Couple Content.** This type of resource could be used in a “standalone” mode (without reference to SSTN) but its constituent components could also be referenced as individual resources with SSTN because the meta-data is available.

- **Reference Content.** This type of external resource of which SSTN has no control or authority. Often these are resources that lack the necessary meta-data and are authored and maintained by a third party.

The process of adding an external (third party) resource involves:
1. **Identification.** The resource is submitted either by an existing community user (such as a teacher or mentor) or a third party resource author/provider.

2. **Review.** A qualified user (for example a seconded teacher) then reviews the resource to ensure that it meets this project’s acceptance criteria (such as production values, quality and education value).

3. **Classification.** The resource is then classified for use in the system and the resource is announced to community users who have expressed an interest in this category of resource.

There are a number of issues associated with using resources that are hosted externally (by a third party) including:

- **Resource Integrity and Quality.** Once the resource has been reviewed, classified and accepted it is important that if the resource changes that this is immediately notified and the changes can be reviewed to ensure that the resource is still relevant and appropriate.

- **Resource Availability.** As the resource is hosted externally SSTN has no control over the availability or quality of the link (“bandwidth”) to the resource. If the resource fails whilst it is being used during a classroom scenario this is problematic for the users and teacher alike. By monitoring the availability of the resource automatically we can become aware of quality and availability of individual resources.

In the following sections we illustrate how these issues were addressed for tightly, loosely and referenced integrated content.
5.2 Resource Description Framework

5.2.1 Tightly Integrated Content – “Blast Off To Science"

To promote space-based science and technology Careers Scotland has run a programme of teacher events and school visits with NASA astronauts (Space Explorers 2007). As a prelude to these events schools are required to learn more about the various space programmes and the visiting astronauts. This is done via the SSTN and by use of the (tightly integrated) ‘Blast Off To Science’ web site. This web site features a (teacher developed) activity plan for pupils which includes:

1. **Mission Box.** In this section pupils are set the task of creating their own mission box and investigating what the content might be for “their” mission.

2. **Mission Patch.** In this section the pupils are set the activity of creating a mission patch that involves directed research into the history and meaning of existing NASA mission patches.

3. **Quiz.** This is an on-line assessment that evaluates the information that has been delivered in the previous two stages. At the end of this assessment they are issued with their unique space passport.

4. **Space Passport.** Once the pupil has successfully completed the previous stages of the programme the pupil can print a certificate with their name (and unique reference number) to “allow them” to attend the event.

The main navigation screen from the ‘Blast Off To Science’ is shown in Figure 5 – Blast Off To Science Navigation Screen. This programme of work has been integrated in two different ways into SSTN either as a single discrete element of course work or as three individual elements that the teacher can use in a standalone manner.

![Figure 5: Blast off to science navigation screen](image-url)
5.3 Closely Coupled Integration – “Space Explorers Scotland”

As part of the coordinated activities with the Association for Space Explorers Congress event held in Scotland 2007 (Space Explorers 2007) a web site was developed (Space Explorers 2007b) which delivers four 40-minute lessons that provide an on-line introduction to space science and technology. Each lesson has two versions, one for the S1-S3 and one for S4-S6 ability ranges. The pupils will access the web site and carry out incremental explorative research, building their own on-line research portfolio, before printing out their research at the end of the lesson as a mind-map, timeline or in a notebook format. Alternatively, they can save their portfolio on-line for later use and extend their research portfolio as they complete further lessons. An example screen from the current of this web site is shown in Figure 6: Topic Selection Screen From The Space Explorers Scotland Web Site.

![Topic Selection Screen from The Space Explorers Scotland Web Site](image)

**Figure 6: Topic Selection Screen from The Space Explorers Scotland Web Site**

The learning resources created for this web site are closely integrated but as they are described via RDF they are readily integrated as standalone resources for use within the SSTN system. In this way the learning content and resources can be readily repurposed to use within a different context as required by the individual needs of teachers (for their pupils).

6. Discussion of Challenges and Lessons Learnt

6.1 Overview

In this project we have addressed a number of important issues, some of which were anticipated and others that evolved from our experiences in using SSTN with an active user community. In the following sections we have highlighted a number of these areas, with an outline description and discussions on our experiences and solutions.

6.2 Evolution of Data and Knowledge Structures

The scope and context of this project was sufficiently well understood to realize that data and the representations initially implemented would need to be continually updated as the system evolved. It was appreciated that there would be an ongoing challenge of managing the evolution of not only the data but the
representation of the data. Backward compatibility and evolution were necessary, as the system could not be taken off-line for upgrades as the system is in constant use.

As the project was developed and deployed it was very important to be able to use an incremental approach to extending the scope of the functionality. This was particularly important, as feedback from users was a key factor in meeting the community’s needs. A “one-size fits all” approach would not have been acceptable for this project.

There was a strong desire to integrate with other national and international projects. The interoperability issues with integrating either fully or partially were of interest to this project. Wherever possible it was desirable to adopt and use existing e-learning and metadata standards. This application has developed and deployed ‘virtual sub-networks’ to provide a mechanism for managing change and providing backward compatibility with a changing code base (Whittington 2003). This is a generic technique that can also be applied in other application scenarios.

The project has demonstrated that the semantic network approach can be highly successfully and has shown that this approach is scaleable for future large-scale, real-time scenarios.

6.3 Hiding Complexity with Simple User Interfaces
The users are drawn from various age groups (for example, primary and secondary school pupils) and different skills levels (from industrial experts to primary school pupils). All issues of complexity and representation must be hidden from the end-users.

6.4 Security and Privacy
Within the UK there has been a growing need to ensure the on-line security and privacy of users and in particular those of children and young adults. Our user community can be both inexperienced online users and unaware of the potential threats presented by other children and adults online. To address this, the SSTN programme has deployed a number of safeguards to ensure the security and privacy of its users. These have included:

- **Security Checks on All Participating Adults.** All adults accessing the system are subject to Disclosure Scotland (Disclosure Scotland 2003) checks for their suitability for working with young learners.
- **IT Infrastructure.** A range of standard IT security measures have been implemented to ensure the integrity of the SSTN system. These include user visible elements, such as using SSL communications, as well ‘stealth’ techniques to monitor and record users activity.
- **Active Content Monitoring.** The content of the system is actively monitored – both using automated tools and by visual inspection by the administrators. As each of the users is tracked via the login (including IP tracking and session tracking) any inappropriate activity is quickly identified and reported to the school and teachers.
- **Parental Controls.** Initially in some regions parents were specially ask to sign legal disclaimer forms before their children could use SSTN. Latterly, this has been replaced by an overarching educational region disclaimer that includes SSTN programme as well as other on-line services that are used in schools.

6.5 “Busy” Mentors
Mentors are industrially based volunteers who have busy schedules and SSTN can sometimes be forgotten in the hectic day-to-day business life. The SSTN system continues to provide e-mail based notification but it is also actively evaluating using mobile phone messaging (both SMS and MMS) and instant messaging to provide more immediate notification, information and updates to mentors, teachers and even learners (such as school pupils). It is anticipated that the immediacy of mobile phones will enhance the use of the SSTN and match well with the culture of younger SSTN users.

6.6 Coordinated On-Line and Off-Line Activities
We have found that to build a successful community it is important to have a programme of both on-line and off-line activities. The use of such events – where community members can meet face-to-face – have been particular successfully and this has been adopted in other programmes (such as the teacher induction events and teachers’ “sleep-over” events at science centres). By integrating these activities with the
teachers’ Continuing Personal Development (CPD) programmes it enhances their ICT skills and confidence to deliver the programme whilst still being considered part of their on-going CPD programmes.

In the future we plan to hold national on-line events – such as “Weather Watch Scotland” (Weather 2007) – that involve an integration of off-line activities (measuring temperature, cloud cover, etc) that are then recorded on-line and viewed on 2D and 3D maps of Scotland.

Careers Scotland is also currently (4Q2007) developing a national showcase for science activities in Scotland (Science 2007) which extends this approach to encompass national and regional activities.

We have also found that building “brands” around each of the Careers Scotland products (such as “Blast Off to Science” – “Astro Sheep” – see Figure 5 – Blast Off To Science Navigation Screen) have been highly effective and can be applied to both off-line (posters, event branding, handouts, worksheets, etc.) as well as on-line. This has enhanced the product recognition and awareness in the educational community.

7. Future directions

There are a number of key areas that we are currently exploring for future integration into future projects. These include:

- **Integration of High-Level Functional Content Blocks.** At the present time we have successfully integrated content from external and in-house resources within the unified framework of SSTN. We are now exploring how we can also integrate functional blocks into SSTN from external resources. This would allow us to leverage third party functionality whilst retaining the ease of use of the SSTN user interface.

- **Remote Web Service Integration.** We are exploring a number of options such as Web Services for Remote Portals (WSRP) approach as well as AJAX-based APIs. At this time (1Q2007) we are the early stages of evaluating these approaches.

- **Mentoring.** We have found that mentors often need considerable support to become familiar with modern education language and practices. Often they are unsure of the language used by teachers, aspects of the modern curriculum and the way educationists discuss topics (can be initially inaccessible to the mentors). We are seeking better ways to provide the necessary training support to overcome this issue.

- **Communication and Notification.** Reliance on using solely e-mail based notification can be ineffective where there is no culture of reading e-mails each day. Using such an approach alone can be problematic and cannot be relied upon with disparate user communities. Both direct contact (telephone or mobile phones) and ‘social’ events are vital in building community in such circumstances. We are interested in using various forms of ‘instant messaging’ technologies to enhance the delivery of this programme.

8. In Conclusion

Over the course of this programme we have developed and deployed a national e-learning system to promote science and technology within Scottish education. The primary aim of this project is to encourage young adults to choose careers in Science and Technology as a valid and valuable career path.

This paper has outlined our approach and some of the key lessons learned from this programme. This project has a national user-base and has demonstrated this approach as a valuable and cost effective mechanism for promoting science and technology to young adults. By leveraging the value of other related projects – such as “Blast Off to Science” and “Space Explorers Scotland” – there has been a significant benefit to all of the participating projects.

We have demonstrated its value as a signposting portal to leverage third party educational resources in the classroom. Subsequent and related projects have benefited from the experiences gained in this programme.

We have demonstrated the practicality and value of provide fully and semi-automated assistance for lesson planning and reporting in the modern Scottish classroom.
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Further Information

Further information about the SSTN project is available from our main publicity web site at [http://www.sstn.co.uk/](http://www.sstn.co.uk/). Participant in the SSTN project is open to all schools in Scotland. Please contact your regional administrator for further details.

References